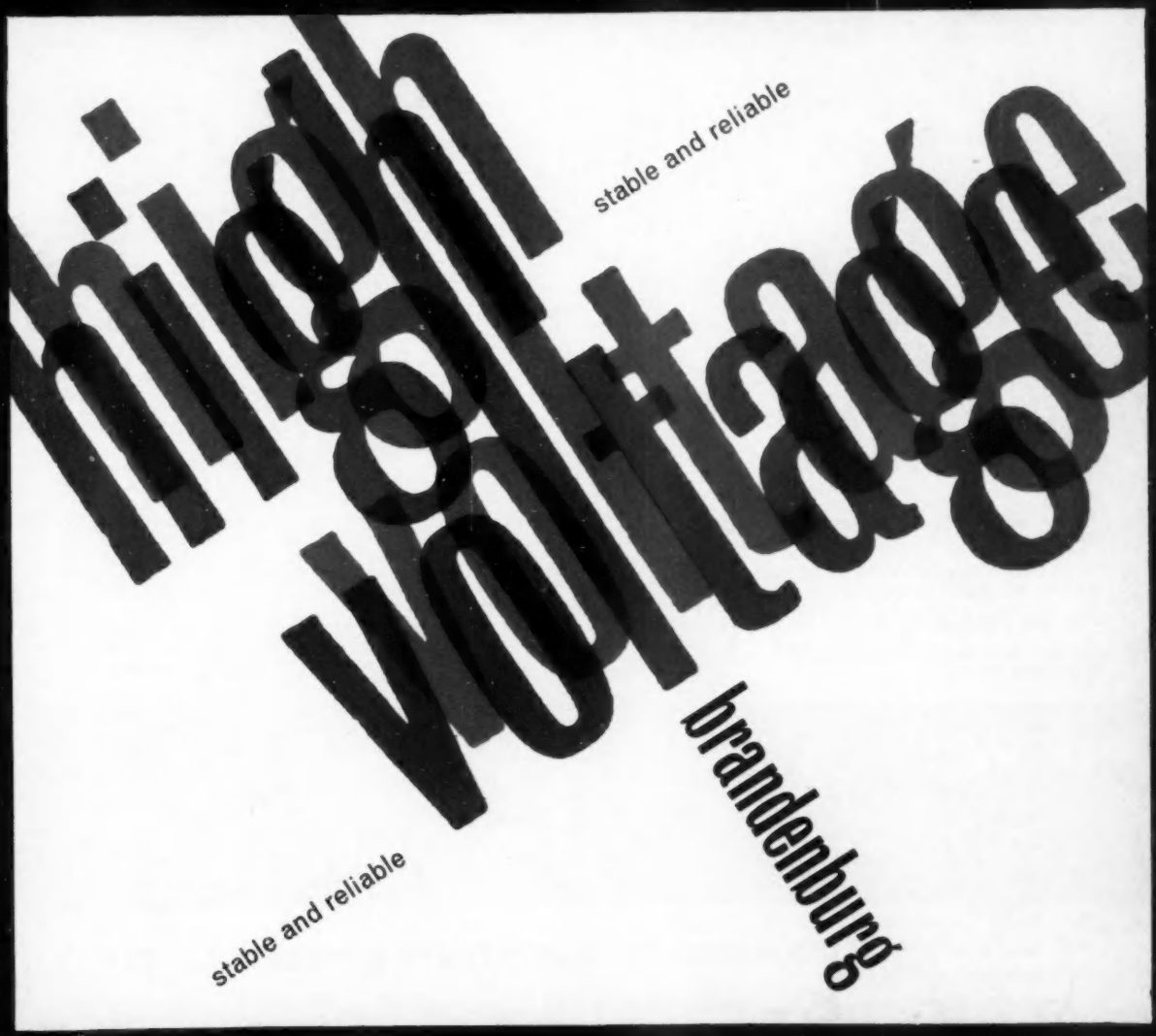
Electronic Engineering



EE 40 002 *for further details*

farnell

TRANSISTORISED VOLTAGE REGULATED POWER SUPPLY UNITS

TSV 30/5 EC

With Electronic Cut-Out and External Sensing

Input Voltage:	110-220 volts with taps 5, 10, 20 volts on both ranges. 40-60 c/s.
Maximum Output Current:	5 amps. continuous.
D.C. Output:	0-30 volts D.C. and continuously variable.
Case Dimensions:	15" long x 11" deep x 10 high (with feet).

U.K. Price: £94

A New Portable Toroidal Primary Transformer

PRIMATRAN

REGD.

- ★ **Never obsolete—any voltage—any time.**
- ★ **Useful for demonstrations of transformer principles to students.**
- ★ **Ideal for laboratories, etc.**
- ★ **Inexpensive—many transformers from one primary.**

Why search through a shelf full of transformers . . . when the Primatran will meet most of your requirements.

The Primary is a Toroidal winding in a plastic moulding. A 3-pole input socket on one side of the moulding connects the mains to the primary, and when used as a current transformer enables the output to be obtained from the same socket. When used as a voltage transformer the secondary winding is wound round the outer case, and the ends of this winding are connected to two terminals on the other side of the plastic moulding. It is possible to wind a number of secondaries on the Primatran for obtaining various secondary voltages simultaneously.

FARNELL INSTRUMENTS LIMITED

LIGHT INDUSTRIAL ESTATE · YORK ROAD · WETHERBY · YORKSHIRE

Telephone : Wetherby 2691/2

Vol. 33 No. 406

DECEMBER 1961

Electronic Engineering

Incorporating ELECTRONICS TELEVISION and SHORT WAVE WORLD

Managing Editor: H. G. FOSTER, *M.Sc., M.I.E.E., M.Brit.I.R.E.*

Contents

771	Commentary	
772	An Audio Frequency Phase Modulator Using Pulse Techniques	*by W. D. Humpage*
777	Automatic Printed Circuit Drill	
778	A Transistorized Data Amplifier	*by H. Fuchs and K. B. Rhodes*
782	A New Meteorological Radar	
783	Silicon Junction Diodes as Variable Capacitors	*by J. Registrar*
788	A Transistorized Pulse-Pattern Generator	*by V. J. Phillips and G. M. Saltmarsh*
791	A Broadcasting Transmitter with Trapezoidal Modulation	
792	A Transistor 50W Audio Amplifier	*by F. Butler*
797	Twenty-five Years of Television Broadcasting	
798	Optimum Transistor Stabilization Networks	*by J. D. Meindl and O. Pitzalis*
803	A Simple Phase Detector	*by G. S. P. Scantlebury*
805	Automatic Data Acquisition for Transistor Life Testing	
806	The Measurement of Luminescence	*by G. P. Burn*
808	Thin Metal Films in Millimetric Wave Measurements	*by M. H. Cufflin*
811	Short News Items	
814	Letters to the Editor	
816	Book Reviews	
818	Electronic Equipment	
824	Meetings this Month	
824	Publications Received	
FRANÇAIS 825	Équipement Électronique	
830	Résumés des Principaux Articles	
DEUTSCH 832	Elektronische Geräte	
837	Zusammenfassung der wichtigsten Beiträge	

Classified Advertisements page 222 **Index to Advertisers page 235**

PUBLISHED MONTHLY on the last Friday of the preceeding month by:
MORGAN BROTHERS (PUBLISHERS) LIMITED
at 28 Essex Street Strand London W.C.2 · Telephone: CENtral 6565
CABLES: Home: 'Lectroning Estrand London.' Overseas: 'Lectroning London W.C.2
MEMBER OF THE AUDIT BUREAU OF CIRCULATIONS
© MORGAN BROTHERS (PUBLISHERS) LTD. 1961
Annual Subscription: Home and Overseas £1.16.0 post free. Canada and U.S.A. $5

EE 40 005 *for further details*

4 NASHTON voltmeters

to Reduce Inspection and Test Costs in Laboratory and Production

TYPE	MODEL	RANGES			FREQUENCY	INPUT Z	ACCURACY OF F.S.D.	PRICE
		VOLTAGE F.S.D.	CURRENT F.S.D.	RESISTANCE				
V 11	AC/DC Valve Voltmeter	1, 3, 10, 30, 100, 300V, AC	-----	-----	50 c/s to 200 Mc/s	1MΩ 3-4 pf	±3%	£47. 0. 0
		DC as for AC plus 1000V	-----	-----	----	10MΩ		
V 12	DC Valve Voltmeter Microammeter	1, 3, 10, 30, 100, 300 1000V, DC	0.1, 0.3, 1, 3, 10, 30, 100, μA	----	----	20MΩ balanced or 10MΩ unbalanced	±3% and 1% 24 hour stability	£81. 0. 0
V 15	Sensitive Valve Voltmeter	30, 100, 300mV 1, 3, 10, 30, 100, 300V, AC	----	----	40 c/s to 500 kc/s	3MΩ 35 pf	±3%	£49. 10. 0
V 17	Universal DC Meter	1, 10, 100 1000V, DC	0.1, 1, 10, 100, μA DC	10Ω to 1MΩ 4 ranges, 3V DC test potential	----	10MΩ for voltage 10MΩ to 1 KΩ for current	±2%	£60. 0. 0

The NASHTON Range — your requirements at a glance.

Look at the performance of these four NASHTON Voltmeters, then look at their prices—they are of outstanding value for money. But that's not all—they bring a new economy to production inspection and laboratory tests by speeding them up. They are designed for ease and simplicity of use and for rapid, mistake-free, repetitive readings under realistic working conditions. Invest in NASHTON accuracy at NASHTON Economic Engineering prices—speed up the vast bulk of your work by quick, dependable, time-saving readings.

TEXAS Instruments Limited use **NASHTON** Voltmeters in their Quality Assurance Department for Production Inspection.

NASH & THOMPSON LIMITED

Hook Rise South, Tolworth, Surbiton, Surrey Telephone: ELMBRIDGE 5252

FULLY SEALED and ENCAPSULATED

to withstand −55° C to +120° C

type A 4

PRECISION WIREWOUND RESISTOR

This new resistor is fully sealed and encapsulated and will meet the H1 Humidity requirements from −55°C to +120°C. The ceramic bobbin is in two sections to reduce the inductance.

Rating:	¼ watt.	
Temperature Coefficient:	Better than ±0.002% per °C or better than ±0.0015% per °C above 1,000 ohms.	
Long Term Stability:	Better than ±0.03% for the first 1,000 hours' use; thereafter, negligible.	
Range of values and Best Tolerances:	0.1Ω to 1Ω	±0.01Ω
	1Ω to 40Ω	±1%
	40Ω to 100Ω	±0.1%
	100Ω to 1 MΩ	±0.05%
Dimensions:	½ in. long by ¼ in. diam.	

Full technical data available from:
Diss, Norfolk
Tel.: Diss 2288

London Sales Office at
551, Holloway Road, London, N.19
Tel.: Archway 0014

Alma
COMPONENTS LTD

Pendeford Multimeter Mk.2 by the Electronics Department of Boulton Paul Aircraft Ltd.

IT COSTS NO MORE TO BUY THE BEST

Specify WESTON on your equipment

The demand created by the high quality of Weston meters is such that production techniques can be employed which enable these outstanding instruments to be produced at competitive prices.

There can be no finer advertisement for your equipment than the name "Weston" on the meters installed

SANGAMO WESTON LIMITED · ENFIELD · MIDDX
Tel: Enfield 3434 (6 lines) & 1242 (6 lines) Grams: Sanwest, Enfield.

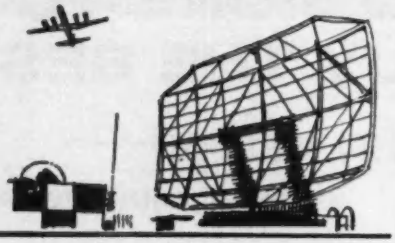
SANGAMO WESTON

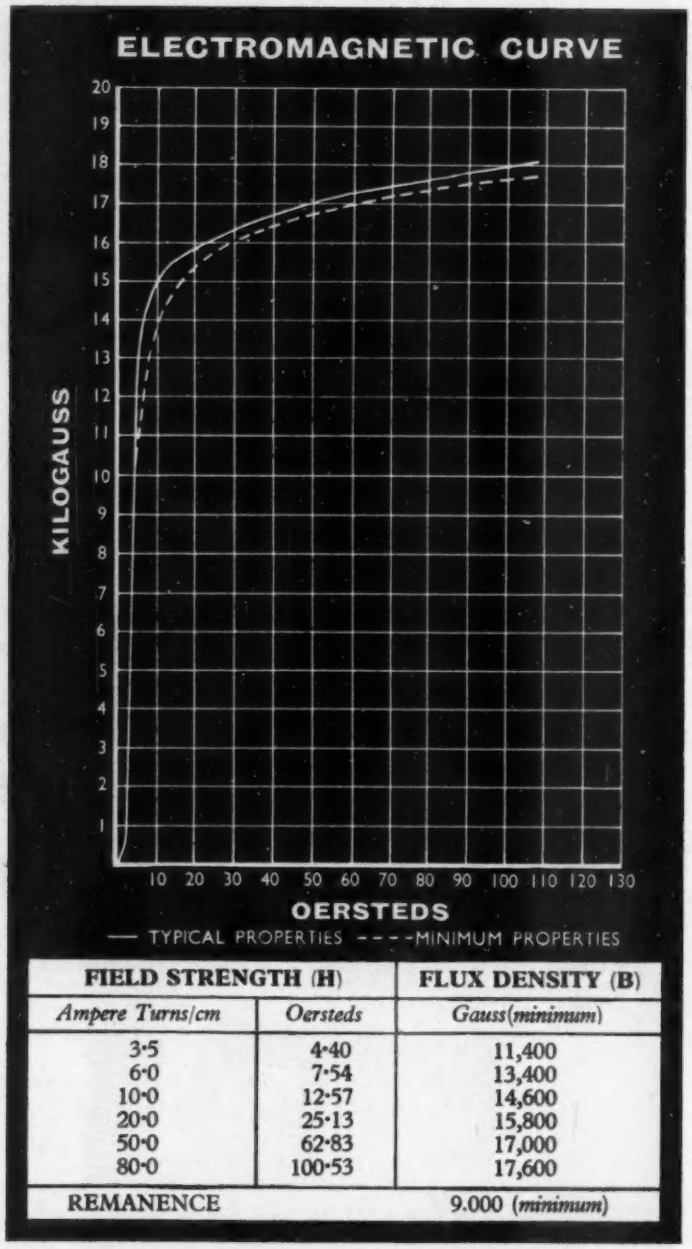
SW/129

The excellent electromagnetic properties of

Purefee AND REFINED MAGNETIC IRONS

These special irons are suitable for a wide range of applications in electrical and electronic equipment. After rough machining, followed by annealing treatment, toroidal ring testing results exceeding the minima shown on the table, can be expected.





FIELD STRENGTH (H)		FLUX DENSITY (B)
Ampere Turns/cm	*Oersteds*	*Gauss(minimum)*
3·5	4·40	11,400
6·0	7·54	13,400
10·0	12·57	14,600
20·0	25·13	15,800
50·0	62·83	17,000
80·0	100·53	17,600
REMANENCE		9.000 (*minimum*)

MIDLAND AND LOWMOOR IRON & STEEL CO. LTD.

Rotherham. Telephone: Rotherham 4211/2/3

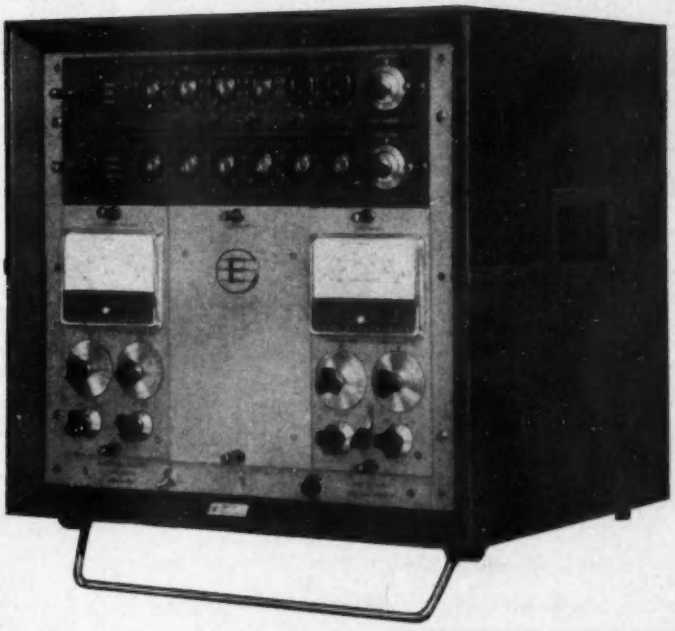
MI 16

EE 40 009 *for further details*

EKCO new automatic scaler

TYPE N610 AUTOMATIC SCALER

This is a combined scaler and timer which incorporates a stabilised HV supply for a Scintillation Counter or G.M. tube, a high gain input amplifier and a pulse height analyser. A ratemeter facility is provided and the timer can be used as a second scaler with its own pulse height discriminator. The timing system is referenced to the mains frequency but provision is made for an external frequency standard to be used. H.T. and L.T. supplies are available for external counter amplifiers. With the addition of a suitable radiation counter it forms a complete counting and timing equipment for most purposes. The centre unit may be modified to enable automatic sample changing and printing systems to be used in conjunction with the scaler.



COMPACT PROPORTIONAL COUNTING

The N610 scaler can be extended to proportional counting analysis by the addition of the Ekco pre-amplifier N688. The noise level at maximum gain is equivalent to about 1 KeV and is ideal for gas flow counters or X-ray counters such as the PX130, or PX28. The total gain of the system is 100,000 with inbuilt differentiating and integrating timer restricting the band-width to 750 K/cs.

EKCO ELECTRONICS

EKCO ELECTRONICS LTD.
SOUTHEND-ON-SEA · ESSEX *Telephone: Southend 49491*

WPS-388

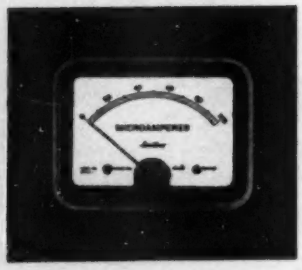
EE 40 010 *for further details*

Instrumentation in Television

Ernest Turner instrumentation at the BBC Television transmitter, London.

Ernest Turner electrical measuring instruments represent the highest standards of design accuracy and workmanship. Clean lines, easily-read scales and attractive appearance combine with technical quality to present precision and industrial grade instrumentation in a wide variety of types, ranges and dimensions.

Full details of all Ernest Turner instruments are given in Catalogue No. 85, available upon request.



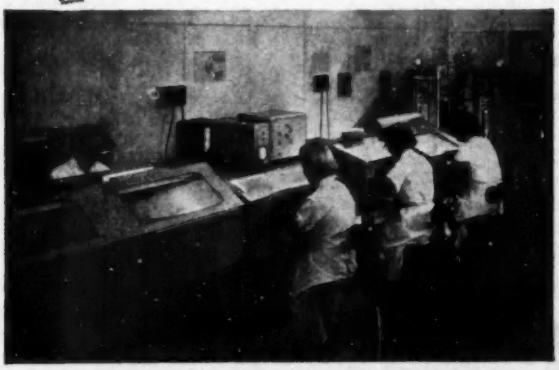
Ernest Turner

ELECTRICAL INSTRUMENTS LTD

HIGH WYCOMBE · BUCKINGHAMSHIRE · ENGLAND

EE 40 011 *for further details*

DRY FOR ALL CHANNELS



Birlec Adsorption Dryer at the AEI Heavy Plant Division, Rugby, drying compressed air for dry boxes in which are assembled germanium powder, semi-conductor, rectifier cells.

Moisture costs money as it slows down production and causes deterioration in quality of electronic components.

Birlec Direct Dehumidifiers—simple, reliable and economical—are already maintaining very low humidities for the manufacture of transistors, computors, radar sets, cathode ray tubes, etc.

AEI-Birlec Limited

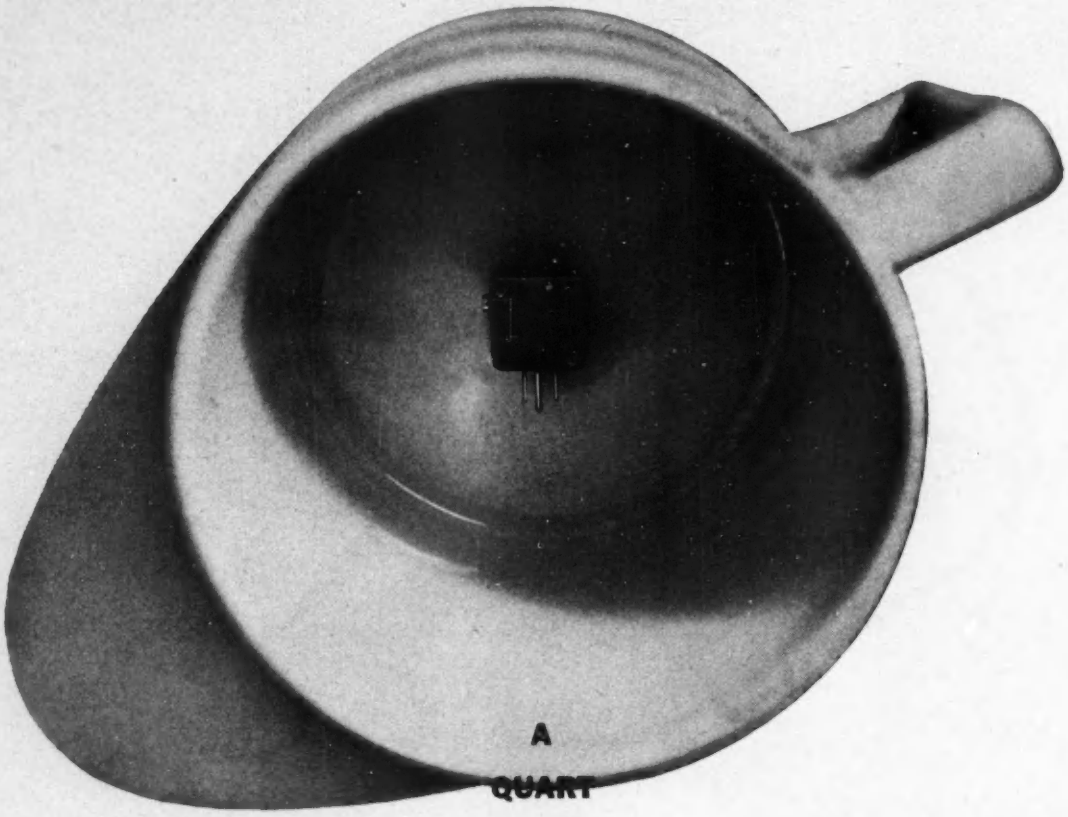
Tyburn Road · Erdington · Birmingham 24

Telephone: East 1544 *Telex No: 33471*

LONDON · SHEFFIELD · NEWCASTLE-ON-TYNE · GLASGOW · CARDIFF

SM/B6230

EE 40 012 *for further details*



A QUART IN A PINT 'POT'

That is exactly what RIVLIN have done with this new component, put a quart of performance into a pint size wirewound pre-set potentiometer. (The illustration is actual size.)

It is of square form which allows versatile mounting and occupies the smallest possible volume—only 0·11 cubic inches. The rugged construction ensures stable settings under vibration and shock conditions and the precision worm drive results in smooth adjustment and absence of backlash. A ratchet mechanism eliminates overwinding. It conforms physically to BSI 3081 for printed circuit applications

Specification:	
Resistance Range:	10 Ω to 10k Ω
Tolerance:	±10%
Temperature Range:	−40 to +70°C Ambient
Weight:	0·1 oz.
Temp: Co-eff:	Less than 20 p.p.m. (±0·002% per °C)
Rating:	1 Watt at 20°C ½ Watt at 70°C
End Resistance:	5%
Stability as Voltage Divider over Temp. Range +20°C to +100°C:	±0·25%
Mechanical Life:	500 cycles (Slider)

PATENT APPLIED FOR

Send for leaflet to:

RIVLIN INSTRUMENTS LIMITED

ril

Yorktown Industrial Estate, Doman Road, Camberley, Surrey.
Telephone: Camberley 2507/8. Grams: Riviectron Camberley.
London Office, Tel: Swiss Cottage 3038.

60 ms

EE 40 013 *for further details*

GD 896

. . . not what we do **but the way that we do it . . .**

Resistors, even precision wirewound ones, no doubt seem commonplace enough. So much ceramic, wire and resin, one inside the other. But, as with many other apparently ordinary products, there's much more in the doing than meets the eye. In the U.K., there's probably no larger or more accomplished company than ours, exclusively concerned with precision resistance. The experience and production facilities, the combination of manual skill and automated processing which we apply lead to manufacturing efficiency so exactly dependable that it is rightly taken for granted. Whether a batch amounts to a handful or to thousands, each one is uncompromisingly up to specification.
Whenever you need precision wirewound resistors, specify RIVLIN.

ril

NEW ENCAPSULATION METHOD Rivlin Instruments Limited have developed a new method of encapsulation, based on epoxy resin, which has the following advantages:—
Wide Temperature Range: —55°C to +120°C, Proof against high humidity, Improved Stability, Interchangeable with earlier types (1—9). All types have precious metal plated terminations.

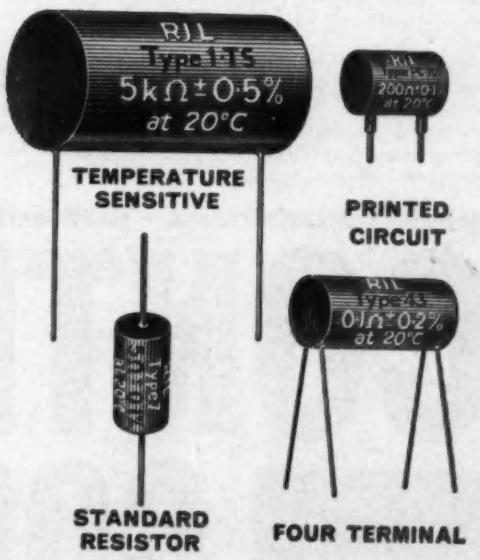
STANDARD RANGE Rating ¼W to 3 W. Range 1 Ω to 3M Ω tolerance to ± 0.1% of nominal value or 0.01 Ω whichever is the greater. Terminals, wire leads or solder lugs, fixing studs can be fitted.

PLUG-IN AND PRINTED CIRCUIT TYPES Rating ¼W (other ratings to order). Range 50 Ω to 200K Ω, tolerance ± 0.1%. Plug-in:—Designed for rapid range changing in recorders, computing networks, voltage dividers, etc. Phosphor bronze pins, gold plated for low contact resistance, plug into Electro Methods type D2 socket (special spacings to order). Printed circuit:—Designed specifically for Printed Circuit use with Phosphor Bronze pins, gold finished, spaced to suit standard Printed Circuit module.

TEMPERATURE SENSITIVE TYPES Range 5 Ω — 10K Ω. Rating to avoid self heating 2.5 mW. Tolerance ± 0.5%. Temperature range —20°C to +120°C. Bobbin or card types available. For use as accurate temperature measuring elements in electrical thermometers (pyrometers) and controls. In feedback networks to compensate for unwanted temperature effects in other circuit elements such as semiconductors.

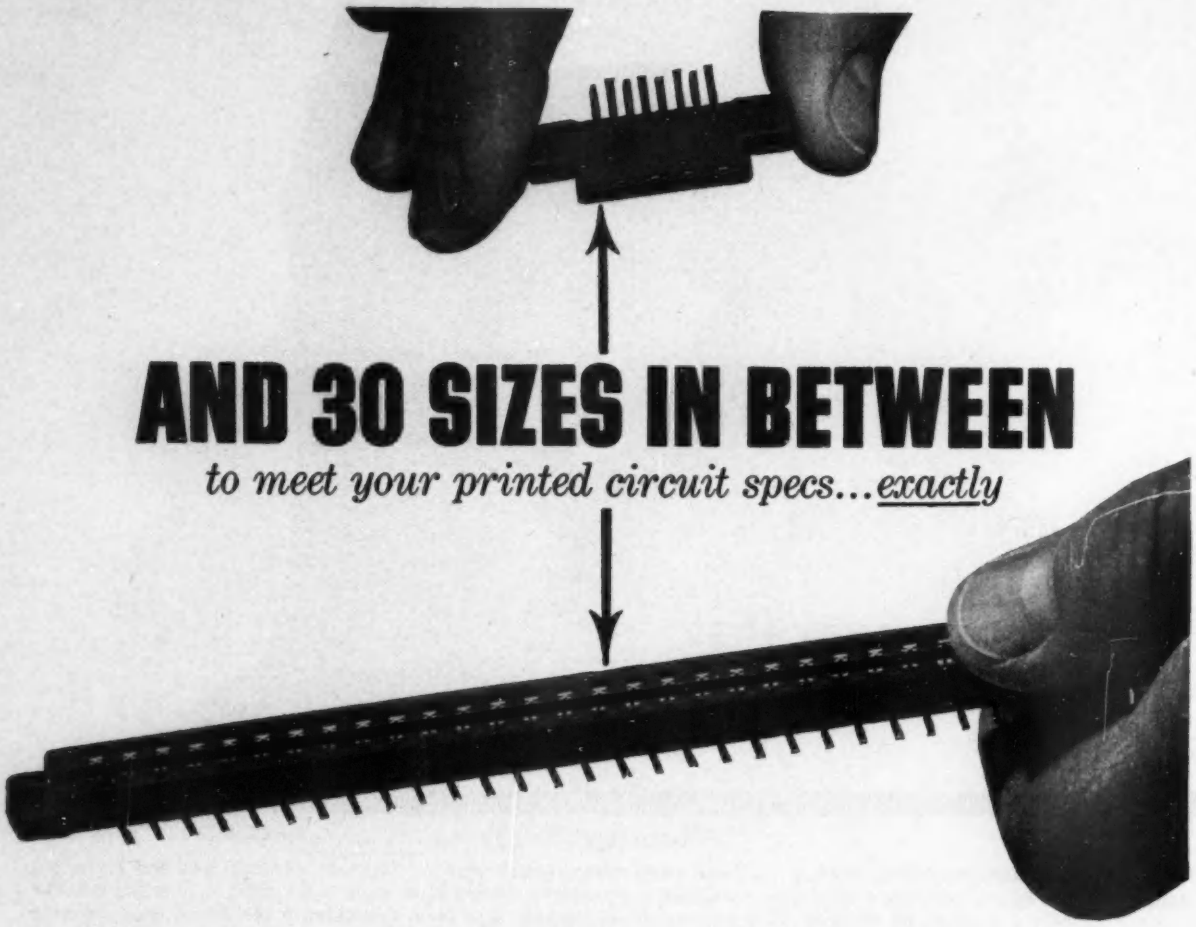
FOUR-TERMINAL RESISTORS Rating ¼W to 6W. Range 100 Ω — 0.001 Ω. Best tolerance above 1 Ω, ± 0.02%; below 1 Ω, ± 0.2%. Temperature range —55°C to +120°C. When accurate low value resistors are required, terminal resistance becomes important and four terminal construction is to be preferred.

NEW PRODUCTION CAPACITY By the recent completion of additional factory, laboratory and office buildings our capacity and scope have literally tripled. Delivery is now 3 to 6 weeks according to size of order. Where high accuracy and consistent performance are vital considerations then RIVLIN is the resistor to specify.



Rivlin Instruments Limited Yorktown Industrial Estate, Doman Road, Camberley, Surrey.
Tel: Camberley 2507/8 Grams: Riviectron Camberley. London Office. Tel: Swiss Cottage 3038

EE 40 014 *for further details*



AND 30 SIZES IN BETWEEN

to meet your printed circuit specs...exactly

Continental's range of Printed Wiring connectors include some 32 sizes and types. Name your requirement — and the chances are Continental has a standard production type that meets it exactly. In addition our American Company can offer a still wider range if your requirement is not tooled in the UK.

These service-proven connectors are available with up to 80 contacts, for 1/16" and 3/32" boards, in both single – and double-row construction. Terminations include solder-spill – – solder lug and contacts for dip soldering. Continental's patented bellowform contacts permit use of undersized or oversized boards while maintaining low contact resistance.

New connector designs are constantly under development. Our Engineering Department will be pleased to assist you in solving special connector problems. Simply call or write, stating your requirements.

DESIGNERS' DATA FILE

If you're designing around printed wiring you'll want to have Continental's Data Sheets compiled to help you select and specify the Printed Wiring connectors best suited to your needs. For your copy, please write to **Continental Connectors Ltd, Industrial Estate, Long Drive, Greenford, Mx, or telephone WAXlow 5721.**

MICRO-MINIATURE • SUB-MINIATURE • MINIATURE • PRINTED WIRING

CONTINENTAL CONNECTORS

CCL

ASSOCIATED WITH THE ULTRA GROUP OF COMPANIES AND WITH CONTINENTAL CONNECTOR CORPORATION, USA

RMS PEAK AVERAGE INDICATION

in terms of db VOLTS dbm

Electronic Voltmeter Type 2409 features:

- **Peak, arithmetic average, and true R.M.S. measurements** by means of specially designed rectifier circuits. The accuracy of the R.M.S. indication is better than 0.5 db for signals with crest factors up to 5.
- **Linear frequency response (to within ±0.2 db) from 2 c/s to 200,000 c/s.** Input impedance 10 MΩ in parallel with 20$\mu\mu$F. To facilitate the use of the instrument as **a calibrated amplifier** it is supplied with screened output terminals. Output impedance: Approximately 50 Ω.
- **Illuminated meter scale calibrated in volts, db with reference to 1 volt and dbm (1 mW into 600Ω).** Sensitivity variable in 10 db-steps from 10 mV to 1000 V full scale deflection.
- **Two different meter damping characteristics,** one of which is in accordance with the standards for VU-measurements, and the other a high damping suitable for measurements of low frequency signals.

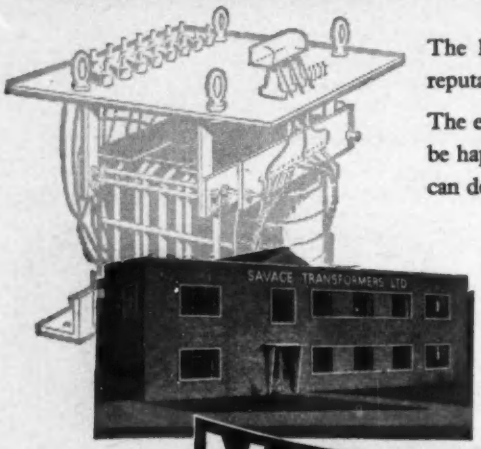
Write or phone for further information.

Ask for demonstration

LONDON, W.1. **4 Tilney Street, Park Lane**

Brüel & Kjær

Tel: GROsvenor 4567 . Cables: BANKLABS LONDON



The little factory is a little nearer to being able to keep in step with its reputation!

The extra space is now available to cope with increased demand and we shall be happy to show new friends as well as old, what goodwill and co-operation can do to make business relations as friendly as they should be.

If you have a control problem, however complicated or simple, write to

THE LITTLE FACTORY
WITH THE BIG REPUTATION

MASSICORE SAVAGE

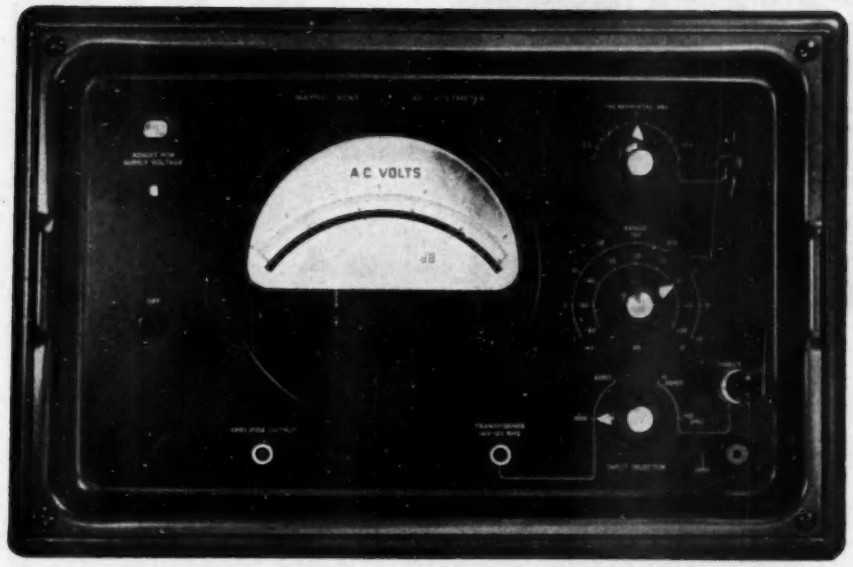
SAVAGE TRANSFORMERS LIMITED
NURSTEED ROAD, DEVIZES, WILTS

Tel: Devizes 932

ST. 103

20 c/s to 100 kc/s -

this r.m.s. Voltmeter is better than 1% f.s.d.



In terms of accuracy, stability and linearity, the Wayne Kerr A.F. Voltmeter M121 is the most advanced laboratory a.f. instrument available today.

Designed for use at frequencies between 20 c/s and 100 kc/s, the instrument has an accuracy of better than 1% of full-scale deflection and can be used up to 200 kc/s with an accuracy of 2%. This high accuracy has been achieved by incorporating the rectifying elements in a current feedback circuit, which not only ensures stability and reliability but also enables the rectifying circuit to be driven from small inputs. In addition, by means of its cathode follower output stage, the M121 can be used as a feed-through amplifier with a frequency response similar to that obtained when using the instrument as a voltmeter. *Write or telephone for an immediate demonstration or for fully comprehensive literature.*

Accuracy: better than 1% of F.S.D. from 20 c/s to 100 kc/s.
Full Scale Ranges: 1, 3, 10, 30, 100 and 300mV r.m.s. 1, 3, 10, 30 and 100V r.m.s.
Meter: hand calibrated, moving coil. Knife-edge pointer, mirror and 6 in. scale. Temperature coefficient 0.01% per °C.
Residual Reading: 20 microvolts due to hum and noise.
Input impedance: input x1—better than 15 Megohms in parallel with 20pF; input x10—1 Megohm in parallel with 15pF; transformer input—600 and 100,000 ohms balanced or unbalanced.

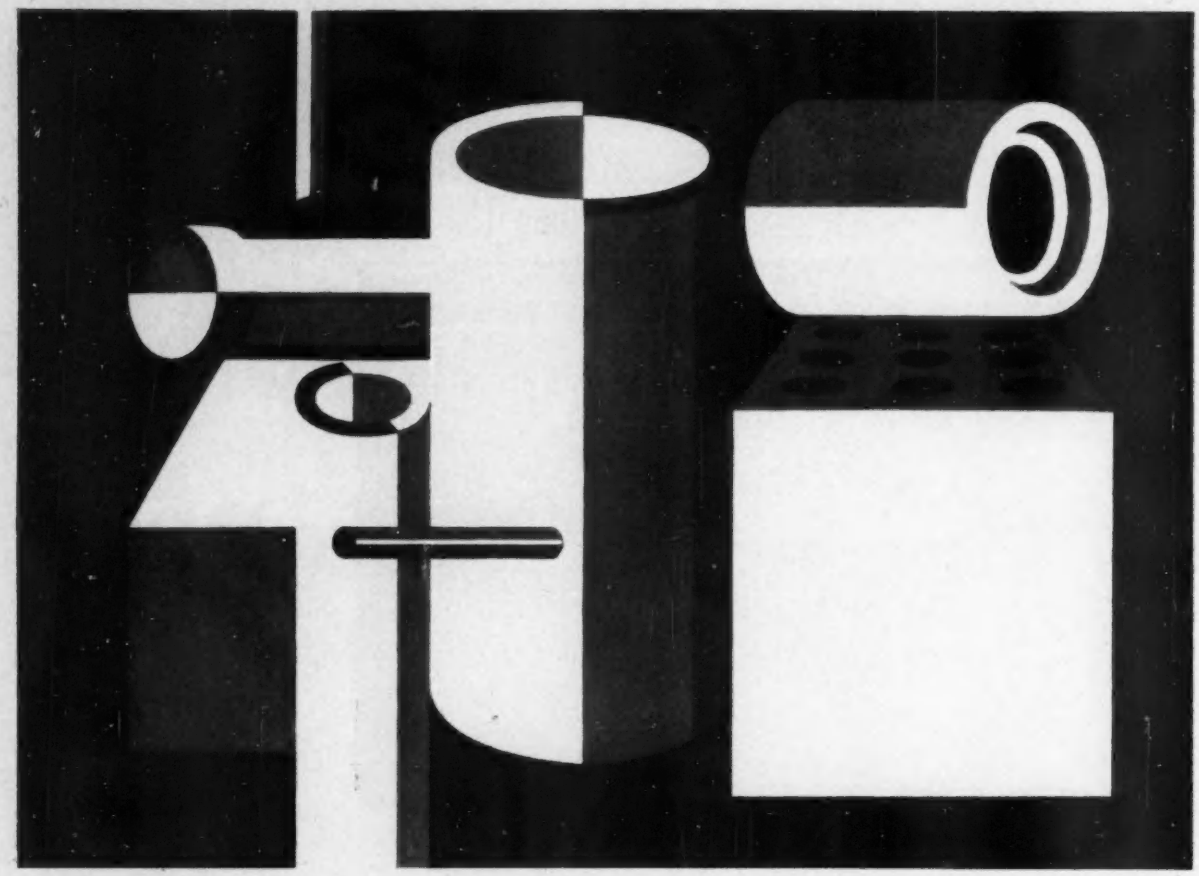
WAYNE KERR

THE WAYNE KERR LABORATORIES LIMITED
New Malden · Surrey · England · Tel: MALden 2202
WAYNE KERR CORPORATION
1633 Race Street · Philadelphia · Pa · USA · Tel: LOcust 8-6820

WK25

EE 40 018 *for further details*

For the Electronic Industry



BERYLLIA
Ceramic Ware

Beryllia electrical ceramics will help designers to create projects which, until now, could not become realities for want of the right material. Already it has answered many difficult problems in electronics, and is the key to a multitude of new possibilities. The combination of high electrical resistivity and dielectric strength, yet with a thermal conductivity comparable to metallic conductors, is unique among refractory materials. Find out about beryllia and get ahead of your problems.

CONSOLIDATED BERYLLIUM LIMITED

Enquiries to our Sales Agent

MORGAN REFRACTORIES LTD · NESTON · WIRRAL · CHESHIRE **Neston 1406**

CHOOSE SIFAM...

Sifam instruments are designed and produced to standards of appearance, performance and reliability which make them the natural choice of leading equipment manufacturers.

We are indebted to W. G. PYE & CO. LTD. for permission to illustrate their new DYNACAP *p*H METER & MILLIVOLTMETER, the most accurate direct-reading *p*H Meter in the Pye Range, which incorporates the Sifam Type M65 Instrument. The seven extended ranges of the instrument give an equivalent scale length of 35 inches, and discriminate to at least 0.01 *p*H or 1 mV.

New and interesting instruments are always being added to our range of production. Our Technical Representative for your area will be glad to show you the newest developments.

Sifam
Instrumentation

If you do not already hold complete Data Sheets for the Sifam Range, please ask for these. A telephone call will ensure that your file is kept up to date.

SIFAM ELECTRICAL INSTRUMENT CO. LTD.

Woodland Road, Torquay, Devon Telephone TORQUAY 63822/3/4

CALCULATINGLY Yours!

Bribond has a larger factory

a new continuous automatic machine for etchings,
a strengthened and reinforced management team,
additional facilities for SUB-ASSEMBLIES,
an extended circuit design department,
a 48 hour prototype service,
and a *MAINTAINED* delivery date.

Whether it's plated in silver, gold, rhodium or tin — flush bonded, double sided or annotated, Bribond knows the technique

Only BRIBOND offers a complete Printed Circuit Service

SERVING THE ELECTRONICS INDUSTRY

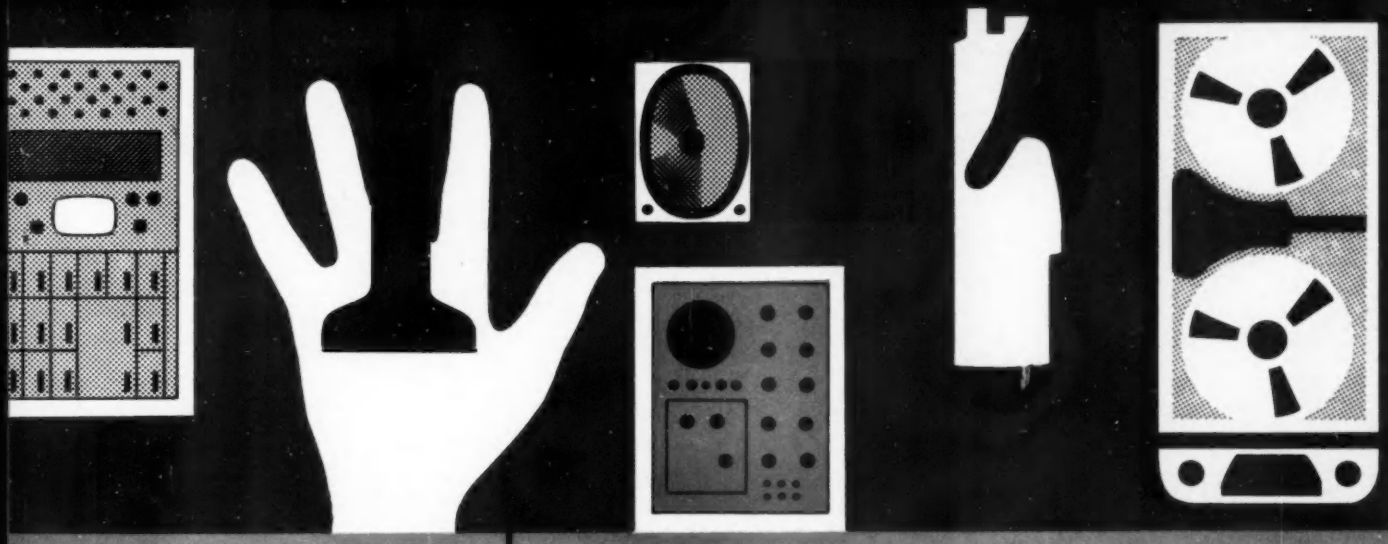
BRIBOND PRINTED CIRCUITS LTD.,

Industrial Estate, Chichester. Telephone: Chichester 3884/5

AYLING INDUSTRIES GROUP

EMI precision instruments

for science and industry



Reply card

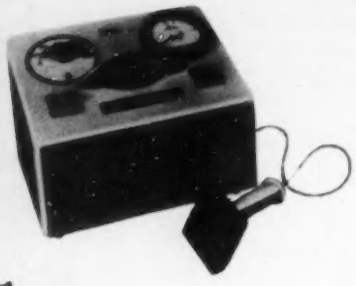
Please send me further details of:

- ☐ Nuclear Health Instruments (and Probes)
- ☐ Emiac II Analogue Computer
- ☐ Emidata Instrumentation Tape Decks
- ☐ Closed Circuit Television (Colour/Black and White/Minicamera)
- ☐ Oscilloscopes (WM16, WM8)
- ☐ Stroboscopes (Type 6, 3D, 5C)

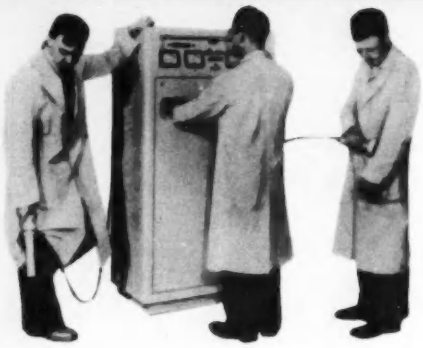
NAME AND POSITION .....

COMPANY'S NAME .....

ADDRESS AND TELEPHONE NO. .....

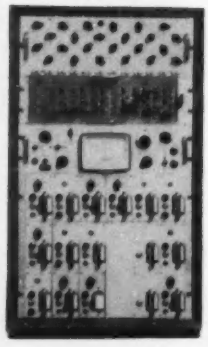


1

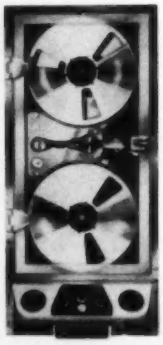


2

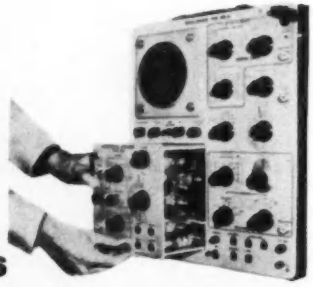
3



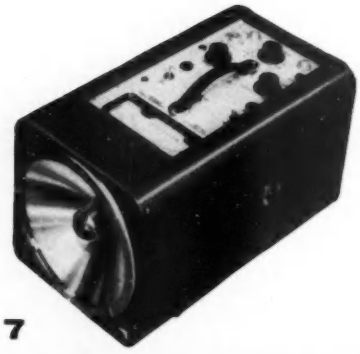
4



5



6



7

Postage will be paid by Licensee

No Postage Stamp necessary if posted in Great Britain or Northern Ireland

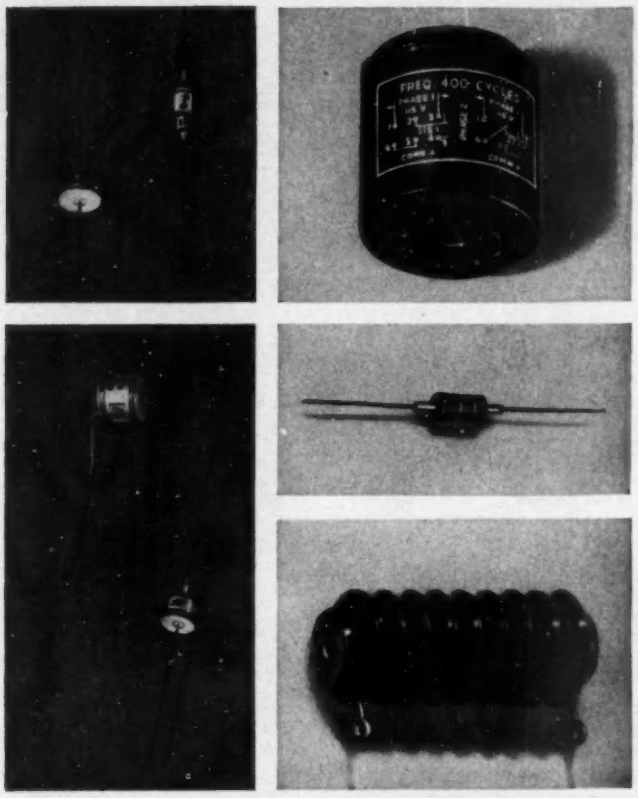
BUSINESS REPLY CARD
Licence No. SOX 64

INSTRUMENT DIVISION · DEPT EC5
EMI ELECTRONICS LTD
HAYES · MIDDLESEX

FOR FURTHER INFORMATION PLEASE SEND THE REPLY-PAID CARD TO EMI

EMI

EMI ELECTRONICS LTD
INSTRUMENT DIVISION · HAYES · MIDDX
TELEPHONE: HAYES 3888 EXTENSION 2223



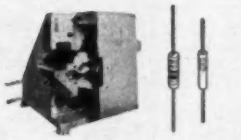
NOW...
MARK THEM AS FAST AS YOU MAKE THEM
with clear, durable, attractive imprints

Here's how typical marking needs are met by Markem

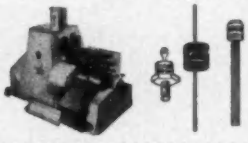
Model 148A — Completely Automatic Marking of all types of surfaces — flat, curved, corrugated, irregular, etc. — without hand rolling or pressing. May be mounted for automatic in-line marking or objects may be hand fed to adjustable work table. Average production 2100 to 3100 per hour.

Model 122A — Simultaneous Top and Side Marking as well as date coding of transistors, similar cylindrical components with base leads. Hopper-fed machine automatically prints and ejects up to 2500 units per hour.

Model 69A — High Speed Color Banding of diodes, resistors, capacitors, similar axial lead cylindrical components. Up to 6 colors simultaneously, or 5 color bands plus typographical marking. Color, band width, spacing easily changed.



Model PAF-AE — Versatility for marking components with axial, one-end axial and radial leads, and components without leads. Production to 3000 per hour. Offset printing unit eliminates rubber plates, and use of Masterplates permits quick changes of all or part of the imprint.



A Markem machine can mark your electrical or electronic product *at production speeds*, even when imprint changes are frequent. More than 40 basic groups of machines have been developed to mark all types of parts and packages using one of the thousands of specialty inks that have been formulated for marking metals, plastics, glass and other materials. We can supply inks for air drying, baking or firing and with resistance to handling, high temperatures, salt spray, humidity and other environmental conditions. With 49 years of experience in the industrial marking field, Markem now offers the world's most complete line of machines, type, ink and supplies — plus helpful advice and service from competent representatives.

Write for this 12-page catalog of Markem machines and related equipment for the electrical and electronics industries. Complete specification sheets are also available for individual machines.

MARKEM (U. K.) LIMITED
24 Brownfields
Welwyn Garden City, Herts, England
MACHINEHANDEL H. RUSCHE
Via Maartensdijk
Hollandsche Rading, Holland

Helping your product speak for itself

modular transistorised high-voltage power

INTERNATIONAL ELECTRONICS introduce in *modular form* their well-proven range of High Voltage Transistorised Power Supply Units now employing Ministry Approved components. A rigid alloy framework encloses each unit and enables four, if required, to be mounted behind a standard 19″ x 7″ panel.

The length of any unit may be increased beyond the dimension stated if required to fit into existing equipment.

A large reduction in volume has been achieved without any sacrifice in performance; indeed, the ratings are now extended to allow operation at ambient temperatures of up to 45° C under suitable conditions of ventilation. The characteristics of low heat dissipation and excellent short circuit protection are, of course, retained.

The units may be set, by simple link-changing, to provide output voltages of 300V, 250V, 200V, 150V, or 100V. Special output voltages remain readily available to order.

Electrical connection to the unit is normally made to turret lugs at the rear but plugs or sockets will be fitted as required.

Excellent accessibility is afforded by easily detachable heat sinks and by a plug-in component-board which runs the entire length of the unit.

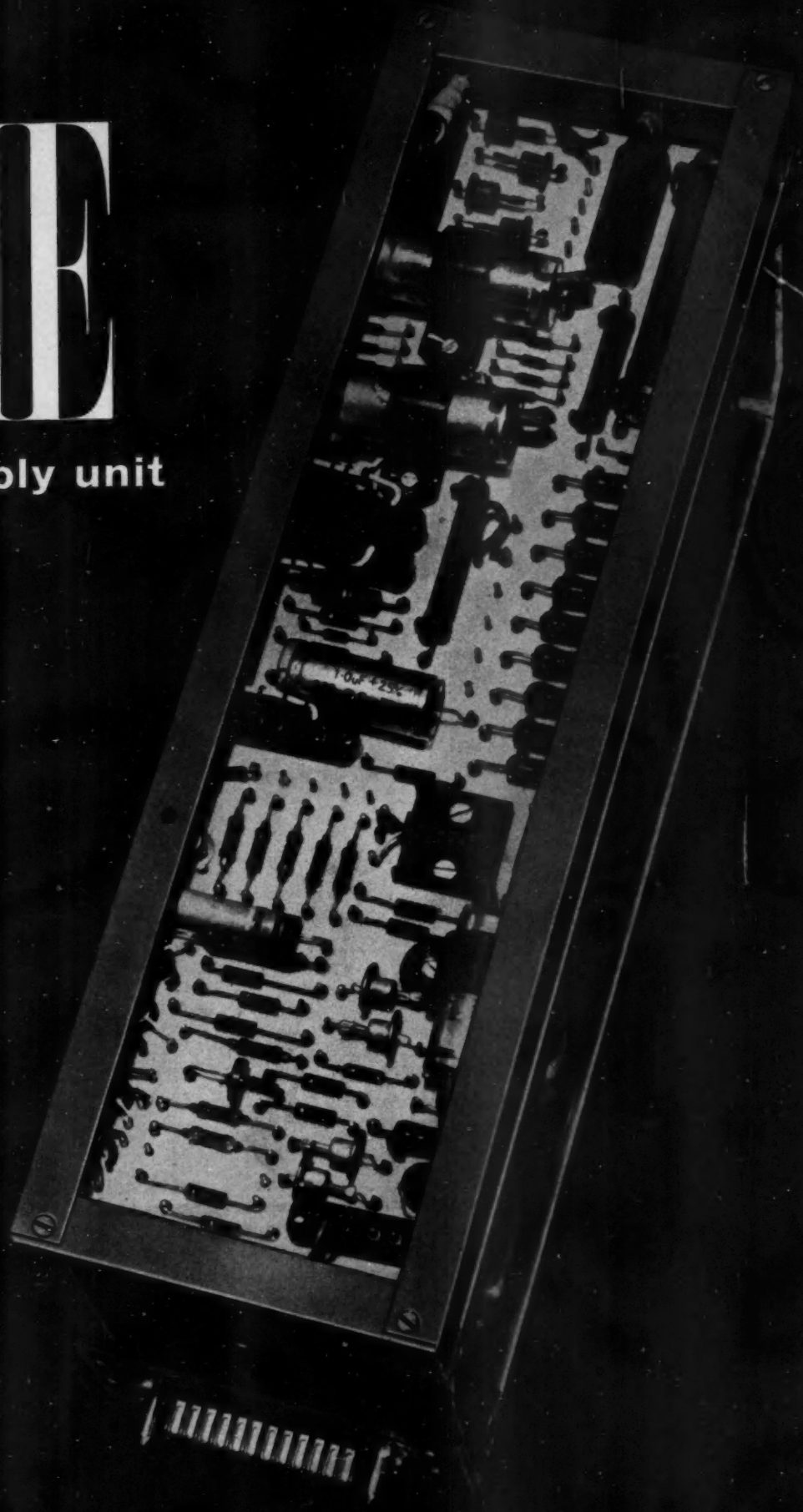
International Electronics Ltd
132-135 Sloane Street London SW1 Telephone SLOane 1396

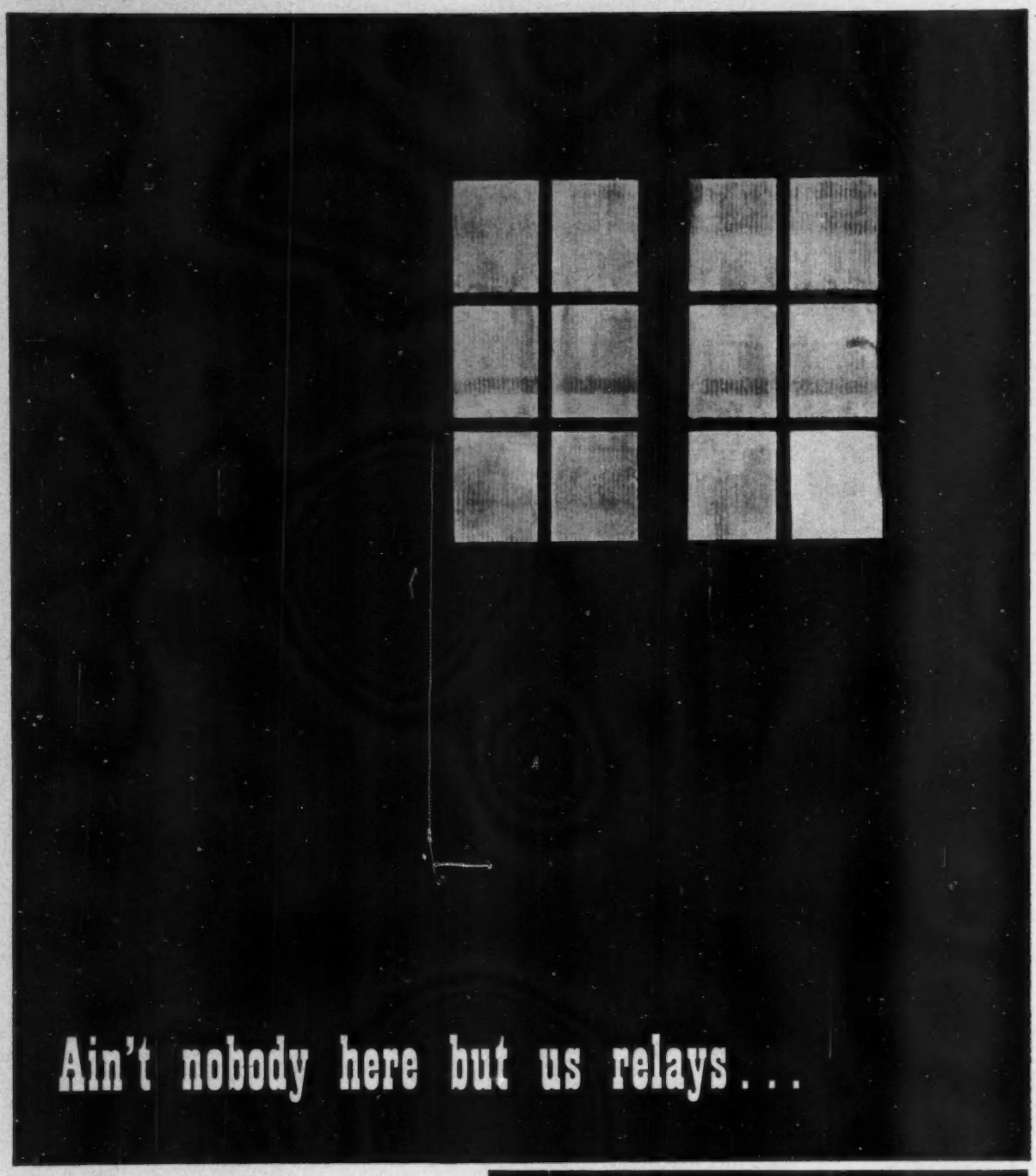
Type No.	Output Voltage	Output Current	Output Impedance to 500 Kcs less than	R M S ripple less than	Stability Factor	Size	Price
DSM1	100 150 200 250 300	100mA	.5ohm	1mV	400: 1	6¾″ × 4¼″ ×11 $\frac{5}{16}$″ (min)	£47
DSM2	100 150 200 250 300	200mA	.5ohm	1mV	400: 1	6¾″ × 4¼″ ×11 $\frac{5}{16}$″ (min)	£58
DSM3	100 150 200 250 300	350mA	.5ohm	1mV	400: 1	6¾″ × 4¼″ × 14″ (min)	£71
DSM4	100 150 200 250 300	500mA	.5ohm	1mV	400: 1	6¾″ × 4¼″ × 14″ (min)	£85

Provisional Patent No. 4670/60

IE

supply unit





Ain't nobody here but us relays...

B. & R. testing of relays goes on 24 hours a day, every working day; even when the factory is closed the testing goes on. There are two basic reasons. One, that we want to be absolutely certain that our relays will have the life we say they will. And two, that they will do the specific things you want them to do—without fail—without doubt. In fact if we might make a point, what B. & R. stand for is reliability.

B&R RELAYS LIMITED

TEMPLE FIELDS • HARLOW • ESSEX *Telephone: Harlow 25231/4*

Member of the Gas Purification Group

MINIATURE D.C. RELAY TYPE B.14.

This inexpensive miniature D.C. relay lends itself to many control applications where space is of prime importance.

COIL

Maximum coil resistance 3800 ohms ±15%.
Maximum coil wattage 2 watts.
Nominal coil power 100 milliwatts.
The relay will operate at 80% of this figure.

CONTACT DATA

One make, break or changeover silver or D54x Silver Cadmium Oxide contact.

CONTACT RATING (RESISTIVE)

1 amp 250 VAC. 3 amps 36 VDC. 4 amps 12 VDC.

SPEED OF OPERATION

Pull-in 15 m/s at 100 mw. Drop-out 3 m/s at 100 mw.

WEIGHT 1 ounce.

The Battery Operated POTENTIOMETER RECORDER that is *COMPLETELY PORTABLE*

The applications listed are examples of Potentiometric measuring and recording hitherto impossible in the industrial field. That they *are* now possible is due to this transistorised instrument which, with its built-in battery power supply is completely independent of mains current and leads (with their consequential limitations).

Very few instruments can claim to have had such a marked record of technical success in such a wide field of industrial and scientific achievement. The MERVYN Battery Operated Potentiometer Recorder claims exclusively to be both *completely portable and self contained* . . . . it weighs only 17 lbs.

- ✱ Internal Battery Power Supply has a life of 250 hours
- ✱ Low Drift Transistor Chopper operating at a frequency chosen to minimise 50-cycle interference
- ✱ Battery-driven motor for the combined Potentiometer and Writing Drive
- ✱ Transistorised amplifier and voltage reference from Zener Diode
- ✱ Inkless Recording using 7-day clock mechanism

The ranges acceptable are from 0–5 mV up to 0–1 volt, by Interchangeable Range Cards

AVAILABLE WITH MINISTRY OF POWER CERTIFICATE OF INTRINSIC SAFETY

Write for further information, mentioning 'Electronic Engineering', to:

MERVYN INSTRUMENTS

WOKING · SURREY · ENGLAND

Telephone: Woking 5200

P841

Mining

Road Construction

British & Foreign Electrical Boards

Health Physics

Tyre Manufacture

Plating Control

Paper Production

Stove Enamelling

Gas Research

Low Temperature Control

Oil Refining

Weather Statistics

Oceanographic Problems

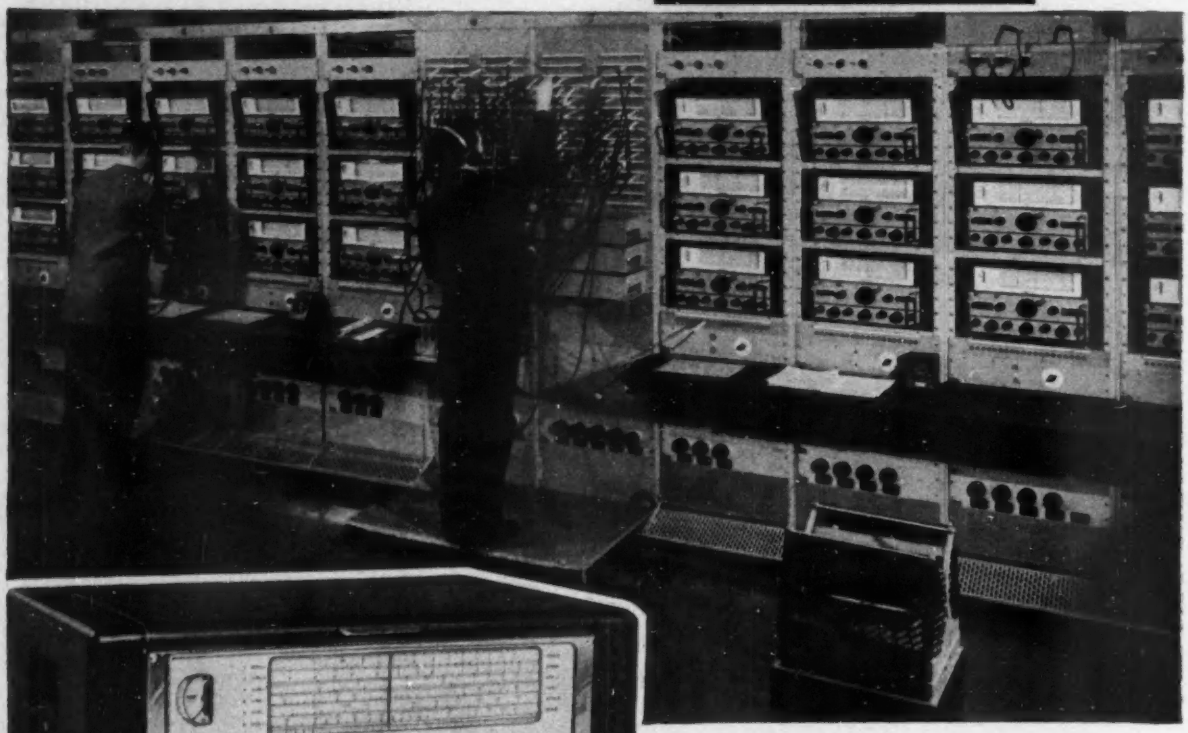
Motor Research

EE 40 026 *for further details*

B·B·C

MONITORING SERVICE

uses the BRT.400



BBC's monitoring station at Crowsley Park, near Reading

BRT.400K receiver

The BRT.400 general-purpose communication receiver is widely used by the British Broadcasting Corporation to monitor programmes from all over the world. Outstanding features of this receiver are its simplicity of operation, extreme sensitivity to weak signals and reliability of performance.

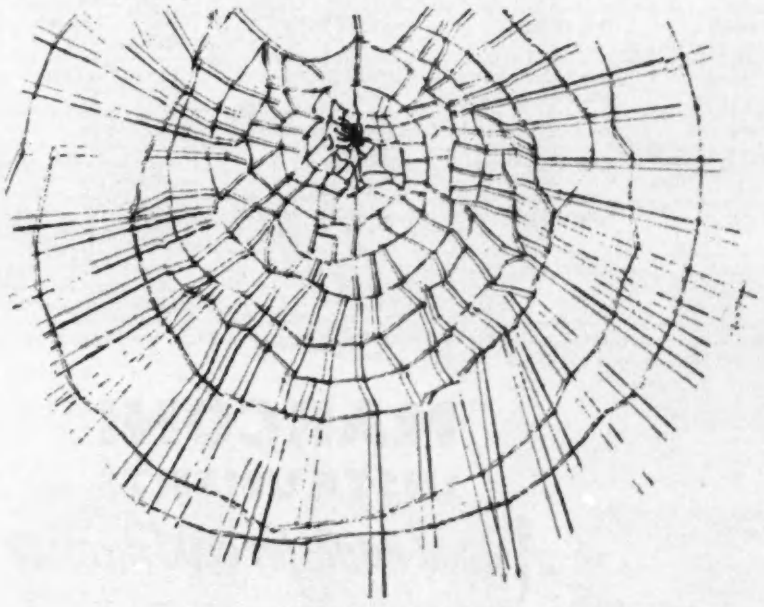
G.E.C.

For full particulars please write to:
ELECTRONICS DIVISION
THE GENERAL ELECTRIC COMPANY LIMITED OF ENGLAND
Lower Ford Street · Coventry · England

Smee's 69

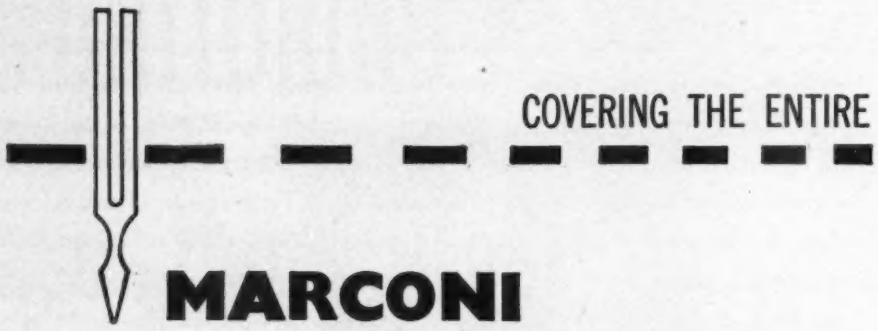
This fellow's data acquisition problems are simple. Just a few channels of information to contend with. But testing a modern aircraft or missile can involve hundreds of channels. That's where magnetic tape recording is helpful. One aircraft manufacturer recorded 420 channels of data in a single two-hour flight test of a new plane. All data were time-multiplexed on to one reel of tape using a pulse-width-modulation technique. Using another multi-channel recording method, an entire 3-stage Minuteman missile was recently tested in a single flight. 15 minutes of pulse-code-modulated digital data were recorded on advanced Ampex FR-600 recorders. These machines are capable of recording up to 120,000 bits per second at a tape speed of 120 inches per second. There are other multi-channel magnetic recording methods, too. By frequency multiplexing, for example, 18 channels of various bandwidths can be recorded on each track of a magnetic tape. 14 analog or 32 digital tracks (combinations, too) can be recorded on 1-inch tape by a variety of Ampex portable, mobile and laboratory recorders. Frequency response is from DC to more than one megacycle in longitudinal recording, and over 4 megacycles on wideband machines. The advantages of recording multi-channel data on magnetic tape are many. The time relationship of channels recorded on the tape, for instance, is preserved indefinitely for correlation and comparison. These last jobs are simplified, too, because the data are preserved in their original electrical form. Thus the same data can be played back repeatedly for reduction, analysis and computation using a variety of different instruments and techniques. For this same reason the time base of data can be altered. By reproducing at tape speeds different from the recording speed, low frequencies can be speeded up and high frequencies slowed down. For complete information on how magnetic tape recording can help solve your data acquisition problems, write for literature packet No. 3 to: Ampex Great Britain Limited, 72 Berkeley Avenue, Reading, Berkshire, England. Telephone: Reading 55341.

AMPEX



Data Centre

EE 40 028 *for further details*



MARCONI
SIGNAL GENERATORS

MARCONI INSTRUMENTS OFFER YOU THE CHOICE OF NEARLY 30 SIGNAL GENERATORS

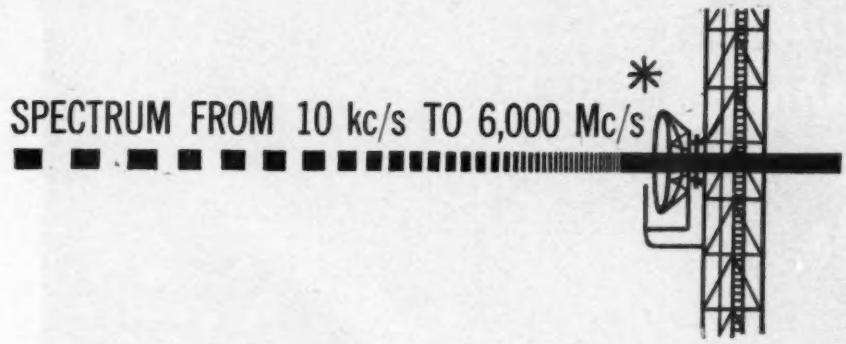
General-Purpose Generators	Frequency Range	Output	Features
TF 144H	10 kc/s to 72 Mc/s	0.2 μV to 2 V 50 and 75 Ω	A.M. up to 80%. Crystal check facilities
TF 867	15 kc/s to 30 Mc/s	0.4 μV to 0.4 V 13 Ω 4 μV to 4 V 75 Ω	A.M. up to 100%. Crystal check facilities
TF 995A/2M	1.5 to 220 Mc/s	0.1 μV to 0.1 V 52 Ω 0.1 μV to 0.2 V 75 Ω	F.M. up to 75 kc/s deviation. A.M. up to 50%. Crystal check facilities. The TF 995A/5 is a narrow-deviation model for mobile radio testing.
TF 1066B & B/1	10 to 470 Mc/s	0.2 μV to 0.2 V 50 Ω	F.M. up to 100 kc/s deviation; incremental tuning to ± 100 kc/s. Also a.m. up to at least 40%. TF 1066B/1 is a rack-mounting version.
TF 801D/1	10 to 470 Mc/s	0.1 μV to 1 V 50 Ω	Sine a.m. up to 90%; also pulse mod. Crystal check facilities.
TF 1064B	68 to 108, 118 to 185, and 450 to 470 Mc/s	0.5 μV to 10 mV 50 Ω	F.M.: 3.5 and 10 kc/s fixed deviation.
TF 1060	450 to 1,250 Mc/s	0.15 μV to 445 mV 50 Ω	Sine a.m. and pulse mod.
TF 1058	1,600 to 4,000 Mc/s	0.1 μV to 445 mV 50 Ω	Squarewave a.m. and pulse mod. F.M. up to 6 Mc/s sweep.
TF 1061	3,500 to 6,000 Mc/s	0.15 μV to 140 mV 50 Ω	Squarewave a.m. and pulse mod. F.M. up to 10 Mc/s sweep. Motor-driven tuning.
TF 890A/4	8,500 to 9,680 Mc/s	+6 dBm to −54 dBm at waveguide outlet	Incorporates c.w. and f.m. signal generator, wavemeter, power monitor, directive-feed assembly, and spectrum analyser with c.r.t. display.

**Radar Test Set TF 890A/4 covers the frequency range 8,500 to 9,680 Mc/s. The frequency range of U.H.F. Signal Generator TF 1145 (not illustrated) is 450 to 1,900 Mc/s.*

MARCONI
INSTRUMENTS
A good name for good measure

London and the South: English Electric House, Strand, London, W.C.2. Tel: COVent Garden 1234
Midlands: 24 The Parade, Leamington Spa. Tel: 1408 North: 23/25 Station Square, Harrogate. Tel: 67455
Export Dept: St. Albans, Herts, England. Tel: St. Albans 59292

SPECTRUM FROM 10 kc/s TO 6,000 Mc/s



HERE ARE SOME OF THEM

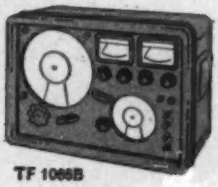
TF 144H

TF 1064B

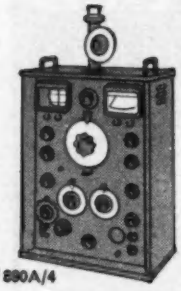
TF 1061

TF 955A/2M

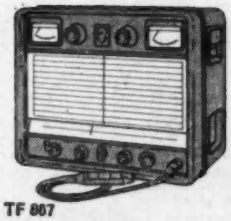
TF 1060



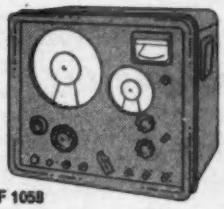
TF 1066B



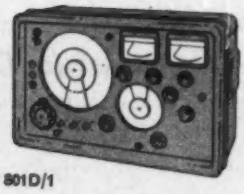
TF 890A/4



TF 867



TF 1058



TF 801D/1

TC 200

✳CO-AX cables
Airflex cables
RG cables
Minicables

✳ ULTRA LOW
CAPACITANCE & ATTENUATION

TYPE	pF/ft	IMPED	O.D.
C1	7.3	150	.36
C11	6.3	173	.36
C2	6.3	171	.44
C22	5.5	184	.44
C3	5.0	197	.64
C33	4.8	220	.64
C4	4.6	229	1.03
C44	4.1	252	1.03

38 STOCK TYPES
for your standard or special applications

TRANSRADIO LTD

138A CROMWELL ROAD LONDON SW7 *Telephone:* FREmantle 4421 (P.B.X.)

To:
TRANSRADIO LTD 138A CROMWELL ROAD LONDON SW7

Please send Cable Catalogue to:

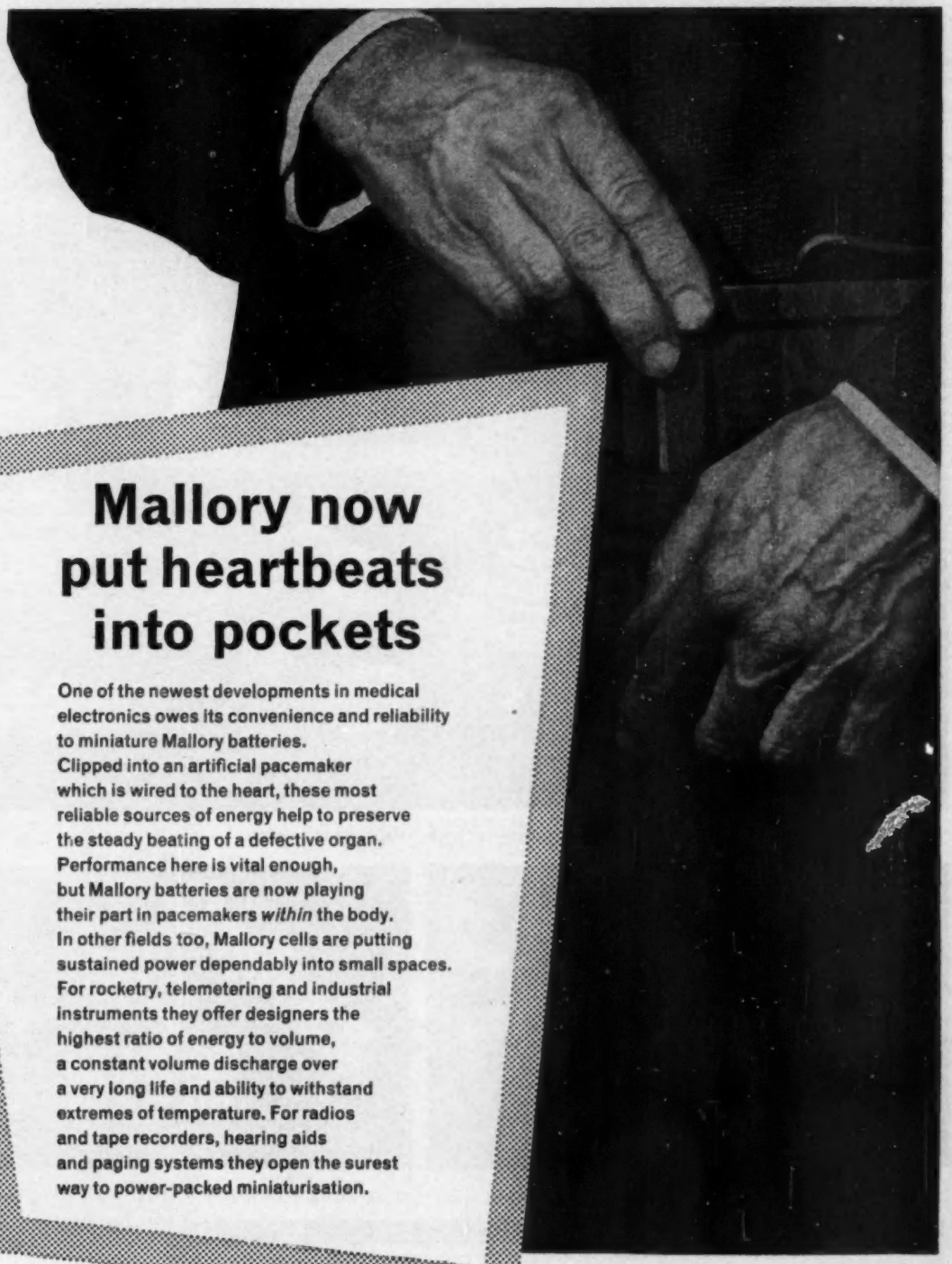
NAME OF COMPANY.....

ADDRESS .....

.....

.....

FOR THE ATTENTION OF..... ● DEPARTMENT .....



Mallory now put heartbeats into pockets

One of the newest developments in medical electronics owes its convenience and reliability to miniature Mallory batteries. Clipped into an artificial pacemaker which is wired to the heart, these most reliable sources of energy help to preserve the steady beating of a defective organ. Performance here is vital enough, but Mallory batteries are now playing their part in pacemakers *within* the body. In other fields too, Mallory cells are putting sustained power dependably into small spaces. For rocketry, telemetering and industrial instruments they offer designers the highest ratio of energy to volume, a constant volume discharge over a very long life and ability to withstand extremes of temperature. For radios and tape recorders, hearing aids and paging systems they open the surest way to power-packed miniaturisation.

Manufacturers are advised to consult Mallory at the design stage so that full benefit can be gained from the world's most space-saving source of power.

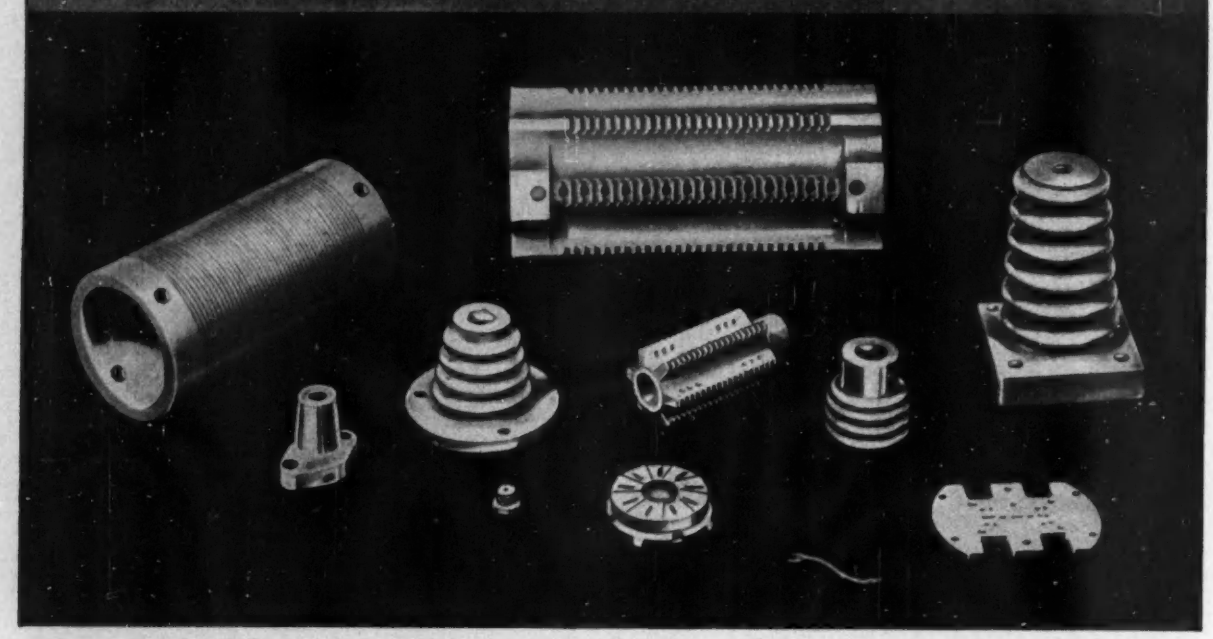
Please write for literature to **Mallory Batteries Limited**
33 Duke Street London W1

MALLORY *miniature batteries for powerful applications*

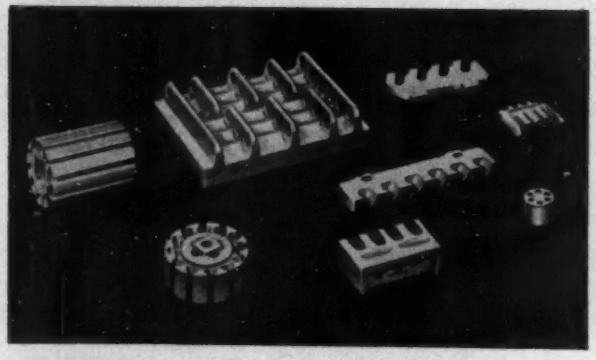
EE 40 032 *for further details*

Bullers CERAMICS

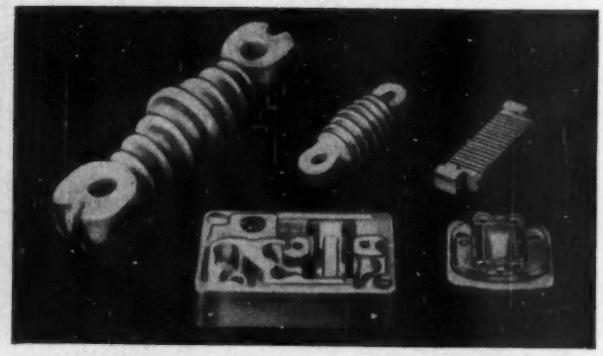
for the **ELECTRONIC INDUSTRY** (and Electrical Appliance Manufacture)



Frequelex—for high frequency insulation.



Refractories for high-temperature insulation.



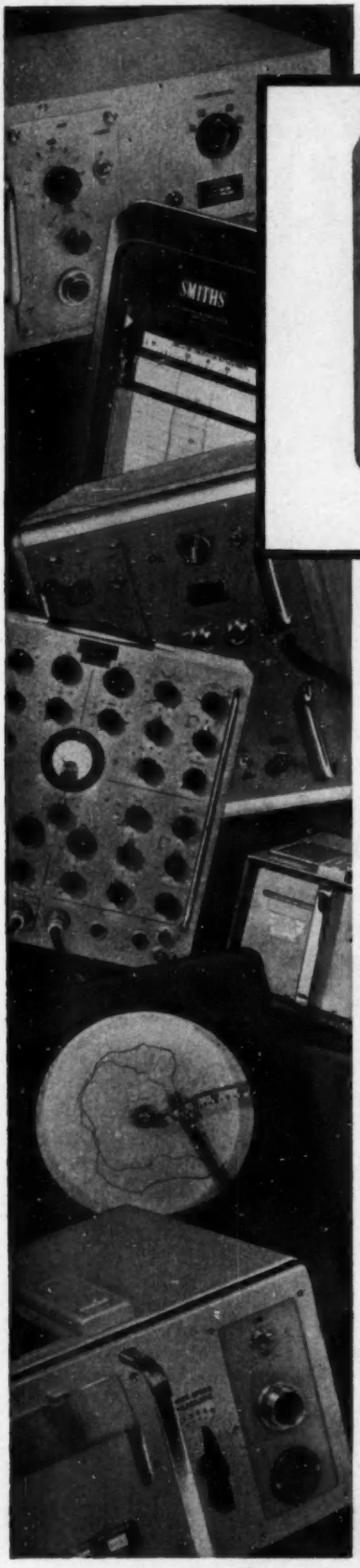
Bullers porcelain for general insulation purposes.

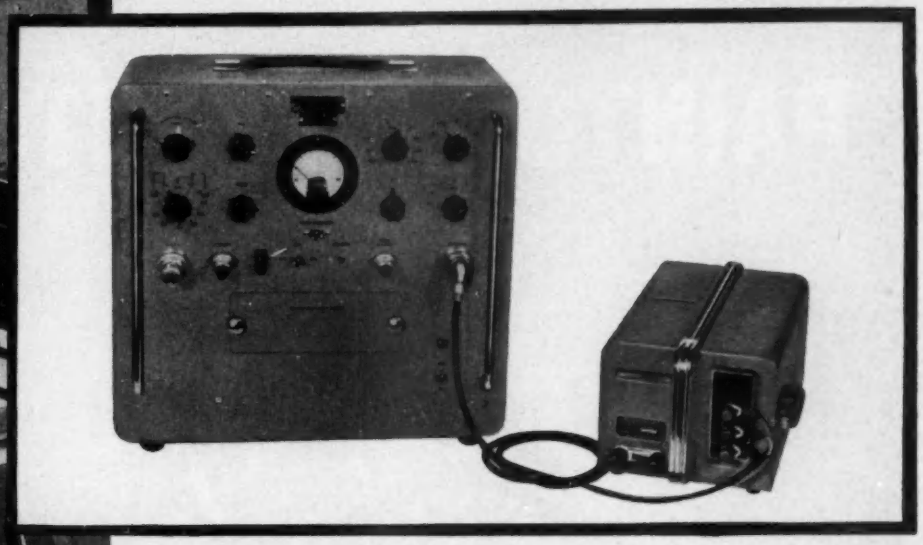
Meticulous care in manufacture, high quality material, with particular attention applied to *dimensional precision and accuracy*, explain the efficiency and ease of assembly when using Bullers die pressed products.

Write today for detailed particulars.

BULLERS LIMITED

Milton. Stoke-on-Trent, Staffs.
Phone: Stoke-on-Trent 54321 (5 lines)
Telegrams & Cables: Bullers, Stoke-on-Trent
London Office: 6 Laurence Pountney Hill, E.C.4.
Phone: MANsion House 9971





SMITHS recording

Specialisation in high-speed recording techniques enables SMITHS Industrial Division to offer a wide range of instruments for the instantaneous and permanent recording of strain, displacement, acceleration, vibration, speed, temperature, time, voltage, current and many other variables. Illustrated here is a SMITHS Single Channel Dynamic Strain Recorder. This equipment, comprising a bridge and amplifier unit and a high-speed single channel pen recorder, is suitable for operation with resistance, inductance and capacitance pick-up devices. Sensitivity is such that a 1½ cm. deflection can be traced for a .005% change of resistance in a 2,000 ohms pick-up. If you have a recording problem, we will gladly send a Technical Representative to give you fullest details of SMITHS recording resources.

SMITHS range of recording equipment includes: Dynamic Strain Recorders; Potentiometric Recorders; Cage Landing Speed Recorders; High Speed Pen Recorders; Single and Multi-Channel Recorders; Multiline Recorders; Circular Chart Recorders.

SMITHS INDUSTRIAL DIVISION

The Industrial Division of **S. Smith & Sons (England) Ltd**

Kelvin House, Wembley Park Drive, Wembley, Middx. Wembley 8888

SID DRI

EE 40 034 for further details

PAINTON PW SWITCHES

The heavy duty range of Painton PW Rotary Stud Switches are Type Approved to DEF 5154 and have a long history of successful and reliable operation in many important applications. Both Heavy Duty and Standard types are available.

RECENTLY INTRODUCED—a new 6 pole version in both heavy duty and standard ranges.

We would like you to have full information about these components. Please write for technical details.

PAINTON

Painton
& CO. LIMITED
KINGSTHORPE · NORTHAMPTON
Tel: 34251 (10 lines) Grams: 'Ceil' Northampton Telex: 31576

A complete 50 c.p.s. Servo Unit by WALTER JONES

1 **THE MOTOR**

a comprehensive range of 2 phase 50 c.p.s. servo motors, 30, 40, 60, 90, 110, 150 oz. inches stalled torque. Designed to comply with joint Services' requirements for shock, vibration and climatic conditions. Class F. insulation.

2 **THE TACHOMETER**

Suitable induction or d.c. tachometers can be supplied.

3 **THE GEARBOX**

Manufactured and fitted to suit your specification.

4 **THE CONTROL BOX**

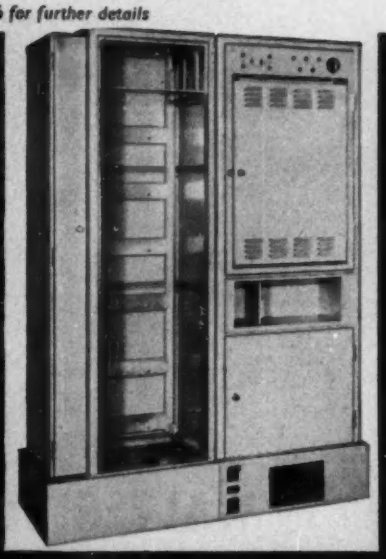
Magnetic Amplifier, 150 watt output, 50 cycles, half-cycle response amplifier having a substantially symmetrical output wave by which the 90° phase relationship of the controlled and reference phase currents of the servo motor is maintained throughout the full range of output.
The amplifier is designed to give an output torque from zero up to 150 oz. inches in both directions by change of control signal polarity.
The control may be either direct current or 50 c.p.s. alternating current, since the amplifier is of the half-cycle response type.
Single stage amplifier requires a direct current control for full operation of 60 mA from a source of 500 ohms.
Two stage amplifier requires a d.c. control current of 2.5 mA from a source of 500 ohms for full output.
Three stage amplifiers are available when required for operation from signals of micro-ampere level.

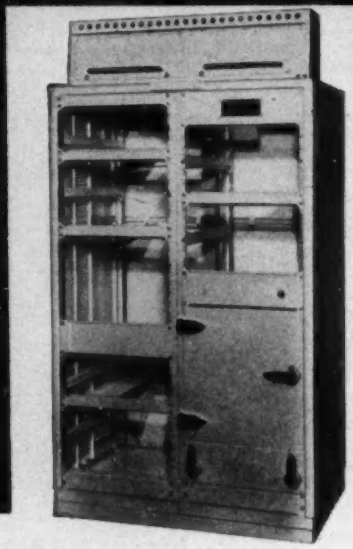
DESIGNERS & MANUFACTURERS OF

Servo Motors:	Converters and Invertors:
Frequency changers:	Permanent-magnet and Electro-magnet d.c. motors, d.c. generators and alternators:
Rotary Transformers:	
Tape recorder motors:	Fan blower motors:
High-speed motors:	Hand generators:
Synchronous motors:	Tachometer generators:
Single and polyphase induction motors:	Speed governors and accurate governor-controlled machines:
Geared motors and gear units:	Speed and frequency error correctors:
Power and audible frequency alternators:	Special research and laboratory equipment.
Motor-driven geared interrupters for the sending of complex repeating pulse trains:	

WALTER JONES & CO. (engineers) LTD. Newlands Park, Sydenham, London, S.E.26. Sydenham 6264-5-6

EE 40 036 *for further details*





These are no ordinary cabinets

These cabinets, specially built to customers' specifications, are typical examples of Hassett & Harper non-standard equipment.

Our engineers — from initial consultation through development and finished production to punctual delivery — can be relied upon to display a keen interest in every job we undertake.

We welcome the opportunity to build special cabinets for unusual applications and we especially welcome those customers who consult us at the very beginning of the job. This not only eases our difficulties, but also results in a more economical and more satisfactory final product.

In addition, there is, of course, the Hassett & Harper Basic Range of Cabinets to fit many requirements. Adherence to Ministry K114E specification is normal.

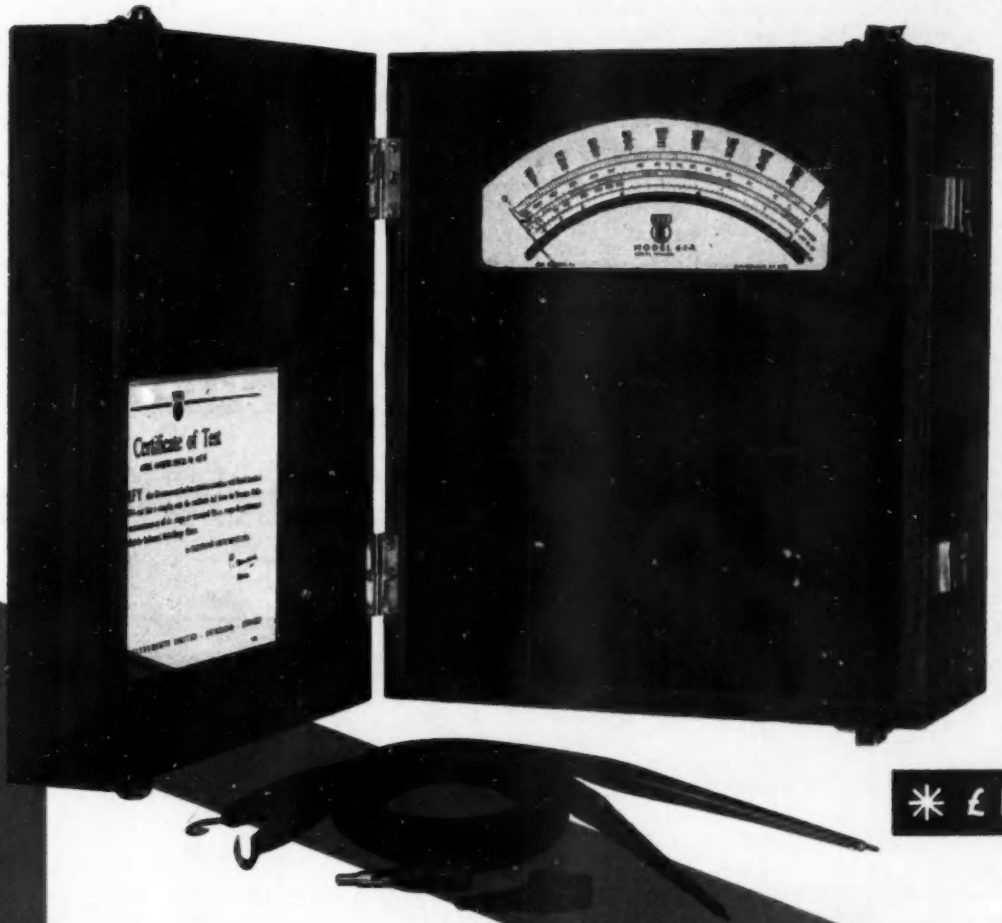
Why not write for literature and Data Sheets?

Hassett & Harper Ltd

REGENT PLACE · BIRMINGHAM 1

Telephone: CENtral 6418

EE 40 037 *for further details*



✳ £118

The Test Room Standard

For close on 21 years the Model 44A Precision Multi Range Meter has been adopted as a standard for checking or calibrating single range meters. It is also widely used in research laboratories where very precise measurements of voltage or current have to be made. Accuracy on the 20 d.c. ranges conforms to B.S.S. 89:1954; that is, 0.3% F.S.D. on all voltage ranges (1V—1000V) and 0.5% on the current ranges (1mA to 10A). On the corresponding a.c. ranges there is no B.S. specification but the errors do not exceed 1%. Although a precision instrument, the Model 44A is very robust and will stand quite severe handling. A patented moving coil cut-out protects the meter movement from accidental forward or reverse overloads. So reliable has the Model 44A proved in practice, that one well-known firm has more than 120 instruments in use throughout its works and laboratories. The price is £118.

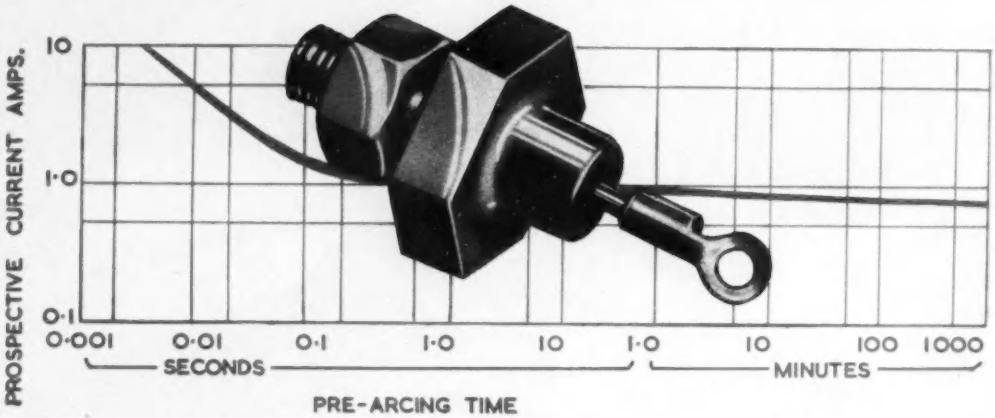
E·I·L

ELECTRONIC INSTRUMENTS LIMITED

RICHMOND · SURREY · ENGLAND · RIChmond 5656

EE 40 038 *for further details*

NEW "Belling-Lee" FUSE-LINKS for Rectifier Protection



These new fuse-links form part of a range which is being developed by Belling & Lee Ltd. for the protection of semi-conductor rectifiers. Because of their small size such rectifiers, particularly the silicon type, have a low thermal capacity, and are therefore rapidly damaged by overloads. This means that in the interests of safety and of minimising operational costs of equipment, as well as to avoid the delays which would be incurred in obtaining and fitting replacements, it is highly desirable to include some form of protection in circuits employing these devices.

The speed of operation of a conventional fuse-link is too slow to afford full protection unless the rectifier is run so far below its maximum capacity as to be wasteful of its capabilities, and also, due to the rectifiers' low internal resistance, the magnitude of the short circuit currents which they will pass requires fuses with a high rupturing capacity. A typical time-current characteristic envelope curve is shown of a suitable fuse-link of heavy duty category; this refers to type L1502. Further particulars are available on request.

List No.	Max. continuous ratings (rectifier)
L1500	250mA
L1501	375mA
L1502	500mA
*L1509	750mA
*L1510	1.0 amp.
*L1511	1.25 amp.
*L1519	10 amp.

Dimensions 1¼" x ¼" Size 0

*****Available shortly*

Most "Belling-Lee" products are covered by patents or registered designs, or applications.

TERMINALS · PLUGS AND SOCKETS · GLASS SEALS
CIRCUIT PROTECTION DEVICES
INTERFERENCE FILTERS · RECEIVING AERIALS
"PRESTINCERT" COMPONENTS

BELLING & LEE LTD
GREAT CAMBRIDGE RD., ENFIELD, MIDDX., ENGLAND
Telephone: Enfield 5393 · Telegrams: Radiobel, Enfield

EE 40 039 *for further details*

FERRANTI HARD VACUUM CERAMIC RECTIFIERS AND INVERSE DIODES

RECTIFIERS

P.I.V. 10 KV to 28 KV

RECTIFIED CURRENTS

40 mA to 200 mA

INVERSE DIODES

P.I.V. up to 22 KV

PULSE CURRENTS

up to 7·5A working

up to 30A fault

	RECTIFIER RATINGS				INVERSE DIODE RATINGS		
	P.I.V.		RECTIFIED CURRENT				
						PULSE CURRENT	
TYPES	NO LOAD	WORKING	PEAK	MEAN	P.I.V.	FAULT	WORKING
UR30	12 KV	10 KV	240 mA	40 mA			
UR40	17 KV	14 KV	450 mA	75 mA	14 KV	8A	4A
UR41	18 KV	16 KV	600 mA	100 mA	16 KV	14A	7·5 mA
DXV18421	25 KV	22 KV	900 mA	150 mA	22 KV	20A	10A
DXV18431	25 KV	22 KV	300 mA	50 mA			
DXV18432	30 KV	28 KV	1·2 A	200 mA			
DXV18451	16·5 KV	15 KV	300 mA	50 mA	15 KV	6·0A	3·0A

FERRANTI LTD.
KINGS CROSS ROAD,
DUNDEE
Telephone : DUNDEE 67141

FERRANTI

First into the Future

DS/T78/2

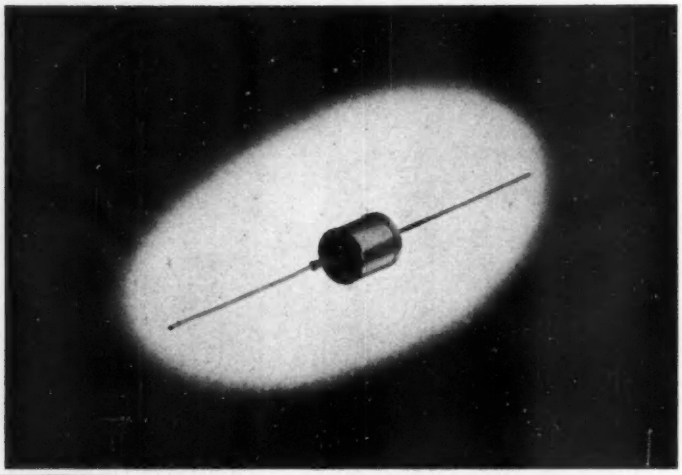
EE 40 040 *for further details*

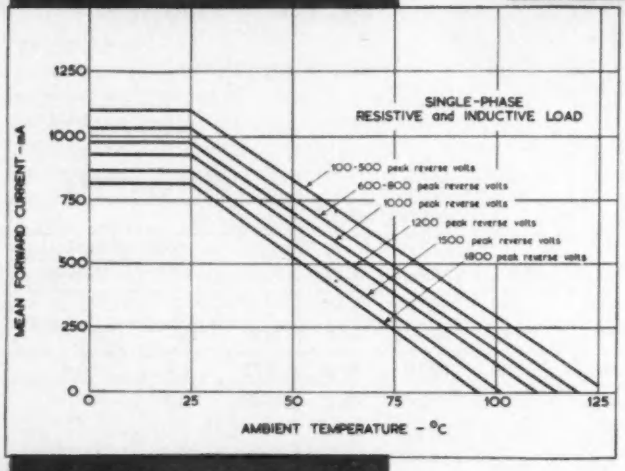
WESTINGHOUSE

LOW POWER SILICON DIODES

S1AR2 — S18AR2

Up to 1100 mA and 1800 volts p.i.v.





SIZE - Body length 7/16 in. (11·5 mm)
Body diameter 3/8 in. (9·5 mm)

Maximum peak surge current - 35 amperes.

Maximum peak recurrent forward current - 10 amperes.

Maximum peak reverse current at crest working voltage and 125°C case temperature - 2mA

Typical capacitance at — 1 volt - 150 pF

Maximum recommended case temperature - 125°C

Other types with lower reverse currents and higher forward currents are also available.

Please write for full details to
DEPT. EE. 12/61 RECTIFIER DIVISION, UNITS SECTION

WESTINGHOUSE BRAKE AND SIGNAL CO., LTD.
82 York Way, King's Cross, London, N.1 Tel: TERminus 6432

A little bit goes a long way with ERSIN MULTICORE SAVBIT ALLOY

SAVBIT for factories

Supplied to factories as standard, in 7 lb. or 1 lb. reels of 14, 16 and 18 s.w.g., packed in easy-to-handle 28 lb. cases.

SAVBIT for service engineers

Supplied on a 1 lb. reel packed in a carton containing approx. 170 feet of 18 s.w.g. Ersin Multicore Savbit Alloy. Price: 15s. each (subject).

SAVBIT for small users

The Size 1 Carton contains approximately 53 ft. of 18 s.w.g. Ersin Multicore Savbit Alloy. It is also supplied in 14 s.w.g. and 16 s.w.g. Obtainable from radio and electrical stores.
Price: 5s. each (subject).

Multicore

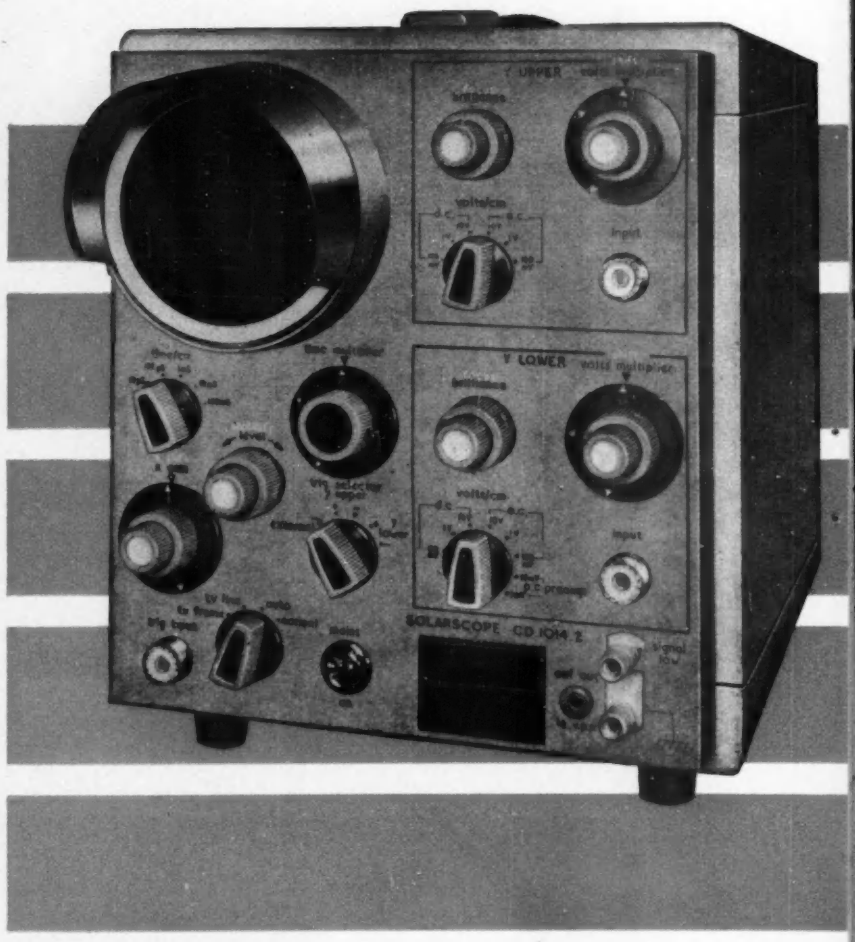
Ersin Multicore Savbit Alloy is manufactured under the British Licence of Patent No. 711,383(4)

MULTICORE SOLDERS LIMITED, MULTICORE WORKS, HEMEL HEMPSTEAD, HERTS. (BOXMOOR 3636)

SOLARTRON

TWO . . . outstanding instruments

double – beam oscilloscope and digital voltmeter



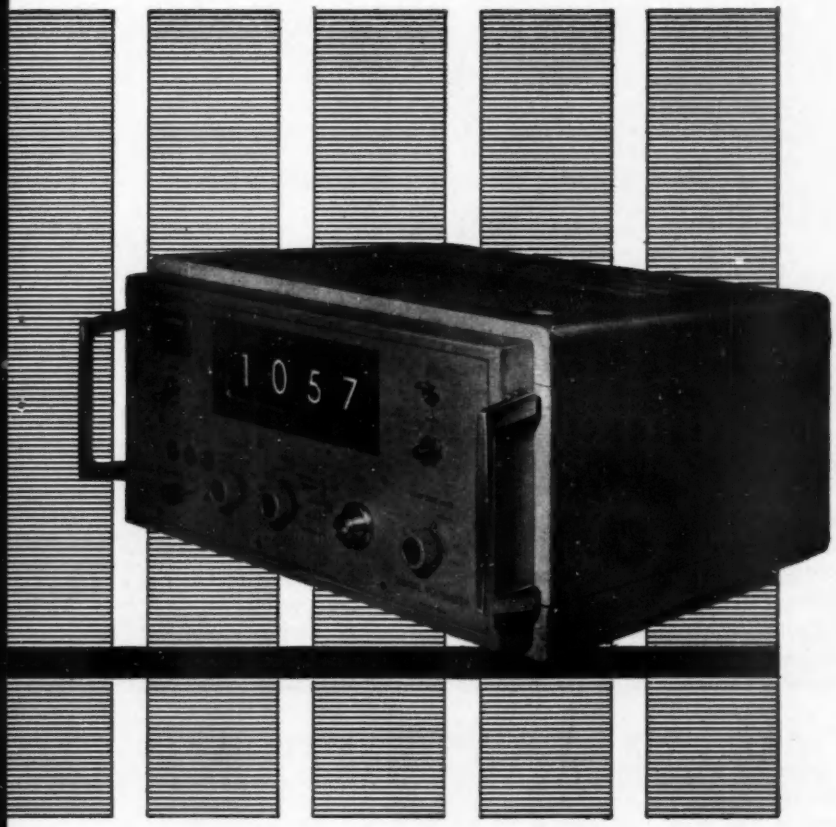
Portable Double-beam Oscilloscope CD 1014.2

The most widely used, low-priced portable oscilloscope. Easy to operate. Versatile. Accurate.

- ★ DC—5 Mc/s (—3dB) on Y_1 and Y_2 (100 mV/cm).
- ★ Max. sensitivity 1 mV/cm on Y_2 (a.c. coupled).
- ★ Sweep speeds 5 cm/μsec—1 cm/sec.
- ★ AUTO, TV Frame and Line, NORMAL Sync.
- ★ Stabilised E.H.T. Provision for external Z.

Rack mounted version on 5¼" panel. CD 1016

Two precision instruments, outstanding in their class, designed for ease of operation with unique methods of measurement and display, functional positioning of controls, instruments of exceptional quality and performance.



4 Figure Digital Voltmeter LM 902.2

100μV—1·599 kV.
Fastest and clearest method of visual display giving 0.1% measuring accuracy.
No interpolation errors.
Print-out facilities.

Please complete and return this coupon

NOW

For further details on these instruments, or any of those listed below, tick the appropriate headings on the coupon and post it to:-

Mailing List Supervisor,
Solartron Laboratory Instruments Ltd.,
Cox Lane, Chessington, Surrey.
(Tel: LOWer Hook 5252)

Digital Voltmeters	
Oscilloscopes	
Oscillators	
Pulse Generators	
f, L and C Meters	
Dynamic Analysis Equipment	
Power Supplies	

Name_____

Position _____

Address _____

SOLARTRON

Reversed polarity versions of Mullard 20 amp Silicon Power Rectifiers bring new economies

To give designers a choice of either cathode or anode mounting, Mullard have added two new, reverse polarity, Silicon Power Rectifiers to their range. These new rectifiers, the BYZ15 and the BYY16 complement the BYZ14 and BYY15—the well known, rugged, 20A, 200 and 400V industrial silicon rectifiers.

The addition of these two new types to the Mullard range of rectifiers not only offers designers more freedom in mechanical design, but also the advantage of reducing the number of heat-sinks required consequently reducing costs and saving space.

ABRIDGED DATA

	BYZ14	BYZ15	BYY15	BYY16
Max. recurrent P.I.V. voltage (V)	200	200	400	400
Max. transient peak voltage (V)	400	400	800	800
Max. average current (A)	20	20	20	20
Max. recurrent peak current (A)	100	100	100	100
Max. junction temperature °C	150	150	150	150
Mounting base	Cathode	Anode	Cathode	Anode

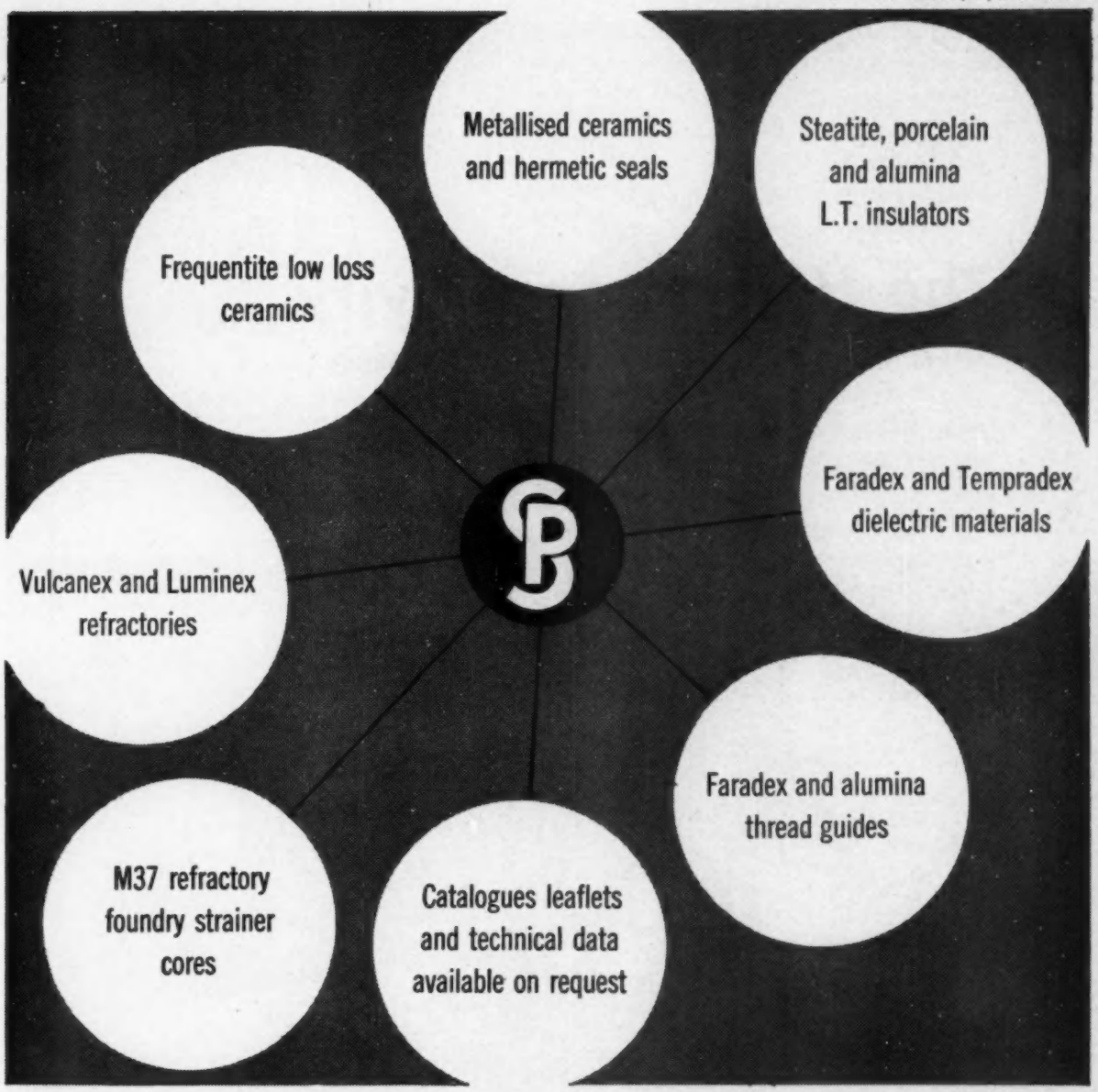
Mullard
semiconductors
for industry

Except for mounting polarity, information on the BYZ15 and the BYY16 reverse polarity rectifiers is exactly the same as that shown on the BYZ14 and BYY15 data sheets. For these or other information, please write quoting reference D4012 to:

MULLARD LIMITED Semiconductor Division Mullard House
Torrington Place London WC1 Tel: LANgham 6633

MIS 40

EE 40 045 *for further details*


Metallised ceramics and hermetic seals
Steatite, porcelain and alumina L.T. insulators
Frequentite low loss ceramics
Faradex and Tempradex dielectric materials
Vulcanex and Luminex refractories
Faradex and alumina thread guides
M37 refractory foundry strainer cores
Catalogues leaflets and technical data available on request

FOR ALL RADIO, ELECTRONIC AND DOMESTIC ELECTRICAL CERAMICS CONSULT:

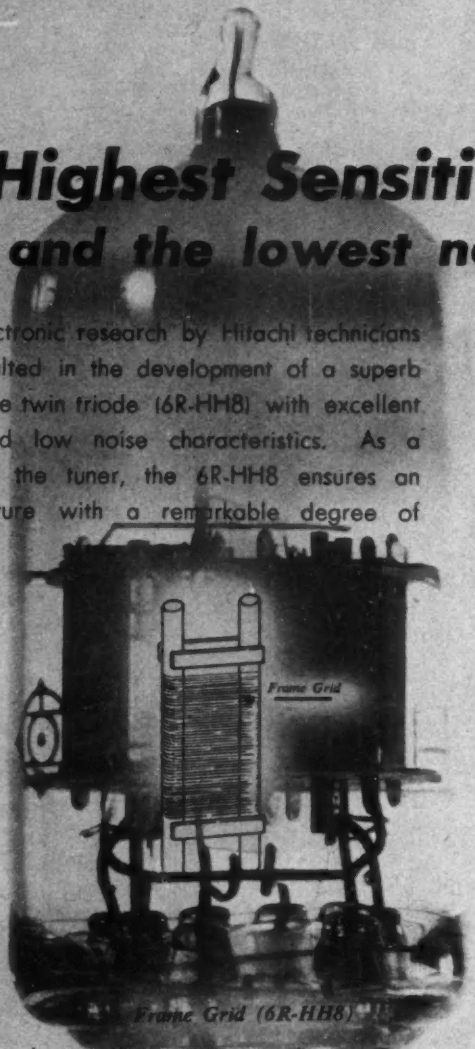
STEATITE & PORCELAIN PRODUCTS LTD.

STOURPORT ON SEVERN, WORCS. Telephone: Stourport 2271 Telegrams: Steatain, Stourport

SP110

The Highest Sensitivity
and the lowest noise.....

Advanced electronic research by Hitachi technicians has now resulted in the development of a superb frame grid type twin triode (6R-HH8) with excellent high gain and low noise characteristics. As a component of the tuner, the 6R-HH8 ensures an excellent picture with a remarkable degree of definition.



Frame Grid (6R-HH8)

fig. 1 Gain characteristics

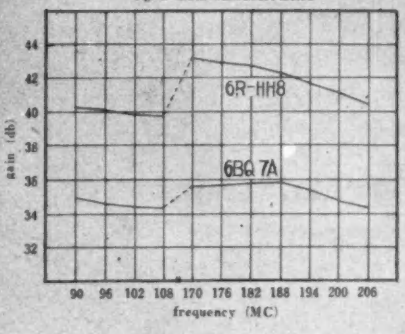
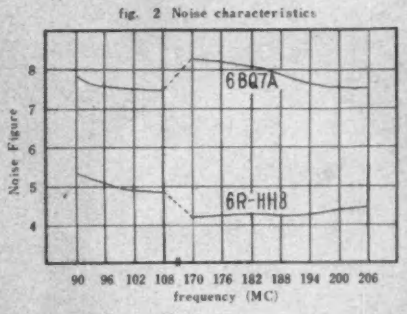
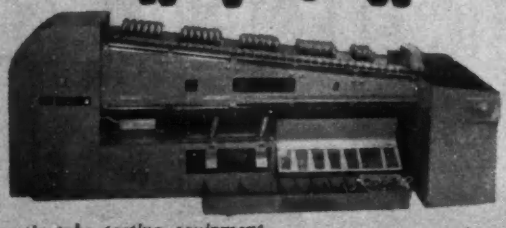


fig. 2 Noise characteristics



Hitachi also produces other receiving tubes and components for television which, when used together with the new 6R-HH8, cannot fail to earn any maker a market reputation even better than he currently enjoys.

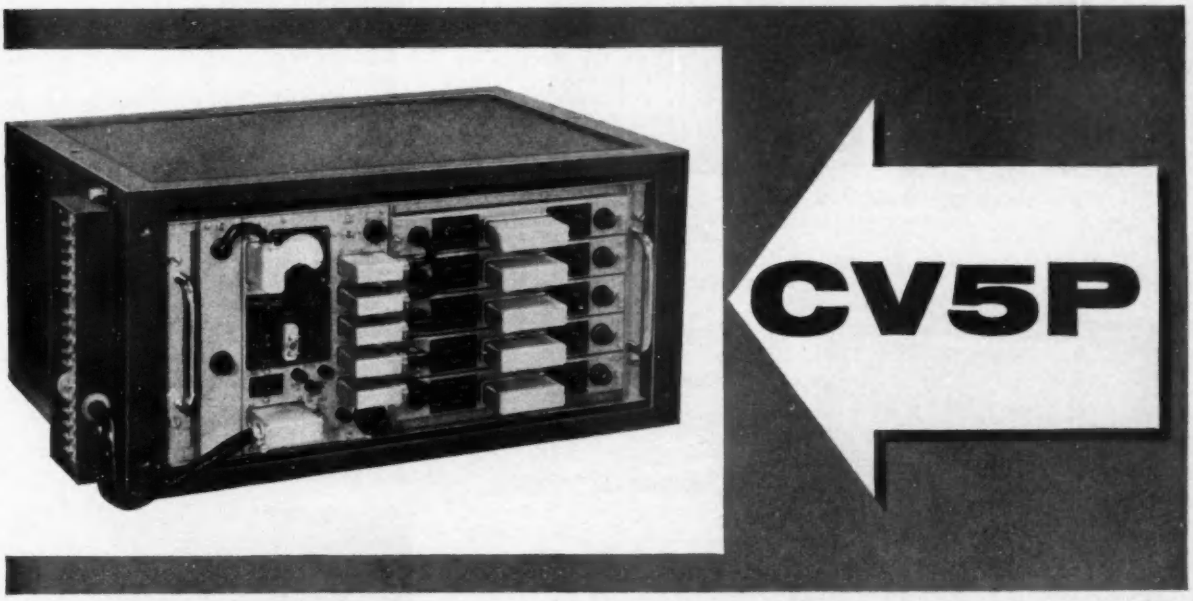


Automatic tube testing equipment

Hitachi, Ltd.
Tokyo Japan
Cable Address: "HITACHY" TOKYO

AEI transistorised carrier telephone equipment . . .

Being fully transistorised, the CV5P is compact and simple to operate—all channels, one audio and four carrier, can be combined for simultaneous duplex operation for transmission over a radio path or two telephone cable pairs. The full equipment consists of only seven sub-units, in a robust carrying case. Each unit—by means of the plugs and sockets—can easily be disconnected, withdrawn and replaced, greatly simplifying maintenance. The equipment is tropicalised throughout.



. . . providing five speech circuits on a radio link

Number of Channels	1 audio and 4 carrier. 4-wire duplex working.
Channel Bandwidth	300 c/s—3000 c/s
Signalling Frequencies (out of band)	Audio channel—4 kc/s Carrier channels—respective carrier frequencies.
Carrier Band Width	300 c/s—20 kc/s
Dimensions of Carrying Case	Width 22½" (57 cms); Height 18½" (47.8 cms); Depth 11" (27.9 cms)
Weight of case	63 lb. (28½ kg)
Weight of equipment	67 lb. (30 kg)

AEI

Telecommunications Division Transmission Department, Woolwich, London S.E.18

Associated Electrical Industries Limited

TA 8/11

EE 40 048 *for further details*

For that special job!

'SL' Desk Type Cases

SPECIFY

Datum

CASES

Designed to perform their function most efficiently, Datum standard instrument cases also present a trim, businesslike appearance. Give your equipment that immediate appeal which brings quick sales.

'LS' Cases

- Fabricated from the finest quality zinc-coated steel.
- Engineered for maximum strength-to-weight ratio.
- Complete interchangeability ensured by special tooling.
- Wide choice of panels, chassis and handles.
- Completely versatile air control arrangements.

'SS' Cases

'CH' Cases

JLT COMPANY

CABINETS · CASES · CONSOLES · CHASSIS UNITS

DATUM METAL PRODUCTS LTD.

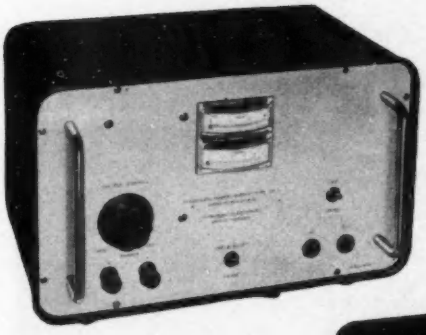
Telephone: Watford 22351
Telegrams: Datum, Watford

COLNE WAY TRADING ESTATE · WATFORD-BY-PASS · WATFORD · HERTS

EE 40 049 *for further details*

NEW THORN TRANSISTORISED D-C SUPPLY UNITS

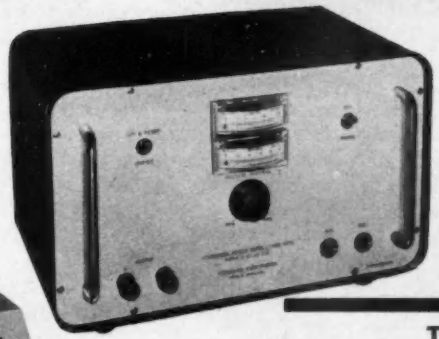
if you're wondering what the price is



HALVE THE NUMBER YOU FIRST THOUGHT OF!

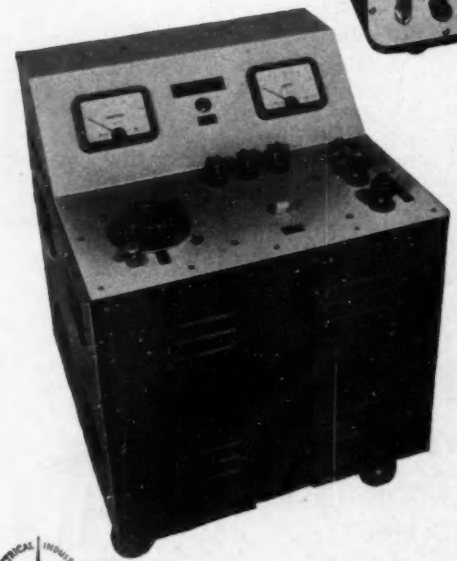
The cost of these two new Thorn units is incredibly low: model V.P.11 comes at £45.0.0, model V.P. 21 at £58.0.0. But if the prices make you feel you're living in a bygone age, the technical performance of the units brings you sharply up to date. Model V.P.11 has a continuously variable output from 3-15 volts at 1 Ampere maximum; model V.P. 21, from 3-30 volts at 1 Ampere maximum. *Both* units have low output impedance, high regulation accuracy, and extremely low ripple and noise. *Both* have fast response electronic overload protection with front panel reset facility. *Both* have voltmeter and ammeter fitted as standard equipment.

The V.P.11 and V.P.21 are ideal equipment for tests on transistorised circuits in the laboratory. If you would like a closer look at either one, you will find our data sheets reveal everything – in microscopic detail.



NEW THORN DC SUPPLY UNIT—TYPE P.U. 11

This new high power DC supply unit has a continuously variable output from 0-30 volts at 30 Amperes maximum, with Germanium rectifiers fitted for high standards of reliability. Altogether invaluable – and altogether only £290.0.0.



TYPE V.P. 11, V.P. 21, P.U. 11

	DC OUTPUT Volts	DC OUTPUT Amps	% VOLTAGE Stability	OUTPUT IMPEDANCE DC	OUTPUT IMPEDANCE AC
Type V.P.11	3-15	1.0 max	0.01	0.01	0.3 at 100 Kc/s
Type V.P.21	3-30	1.0 max	0.01	0.01	0.3 at 100 Kc/s
Type P.U.11	0-30	30.0 max	20.0	0.26	0.1 at 50 Kc/s

	RIPPLE in mV peak/peak	SIZE IN INCHES L x D x HT			WEIGHTS in lbs
Type V.P.11	2	15½	10	10	18
Type V.P.21	2	15½	10	10	18
Type P.U.11	100 at full load	18	18	24¾	170

The present range is being extended to include 'brick' unit transistor power supplies which will cater for any supplies between 3V and 120V DC at 10 Amperes maximum.

The Industrial Control Systems Division also manufactures Failure Alarm Systems, Invertors, Convertors, Photoelectric Switches, Batch Counters and Process Control Equipment.

Write for full particulars to:
THORN ELECTRICAL INDUSTRIES LIMITED · INDUSTRIAL CONTROL SYSTEMS DIVISION · GT. CAMBRIDGE RD. ENFIELD, MIDDX

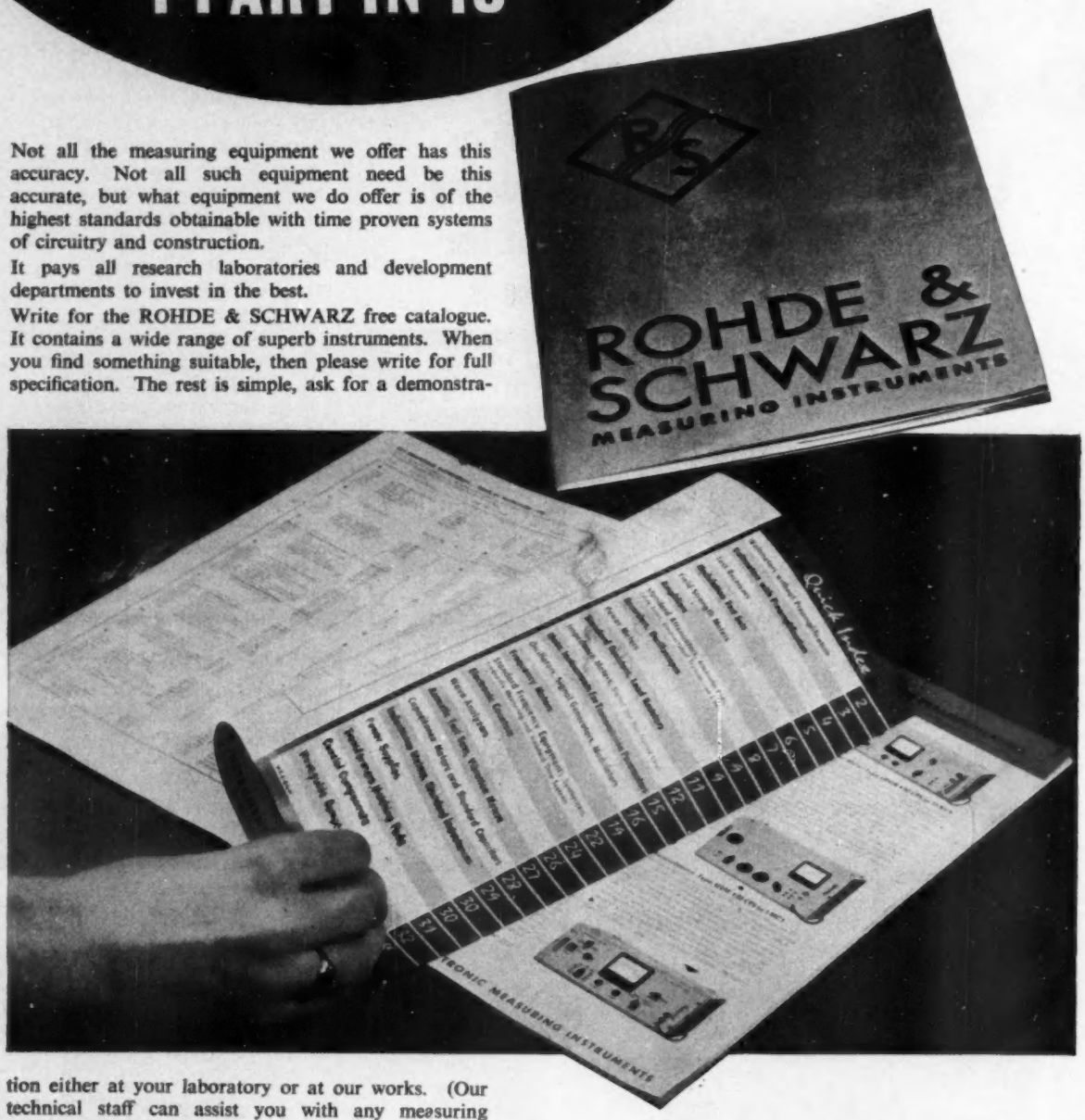
EE 40 050 *for further details*

1 PART IN 10^{10}

Not all the measuring equipment we offer has this accuracy. Not all such equipment need be this accurate, but what equipment we do offer is of the highest standards obtainable with time proven systems of circuitry and construction.

It pays all research laboratories and development departments to invest in the best.

Write for the ROHDE & SCHWARZ free catalogue. It contains a wide range of superb instruments. When you find something suitable, then please write for full specification. The rest is simple, ask for a demonstration either at your laboratory or at our works. (Our technical staff can assist you with any measuring problems which you have.)



All equipment is guaranteed for one year and full servicing facilities are available.

Aveley Electric Limited

SOUTH OCKENDON : ESSEX
Telephone: SOO 3444
Telex: 24120 Avel Ockendon

P.6270

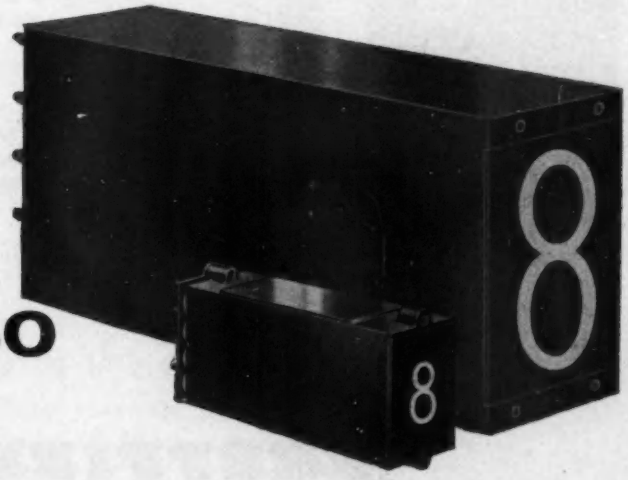
EE 40 051 *for further details*

a calculation of mathematicians

No. 4 PTOLEMY

Ptolemy (Claudius Ptolemaeus, or Claud to his Bank Manager) was a native of Egypt. His birthplace is unknown but it is established that he was born. The 'P' is silent as in Pneumonia, Pnumismatics, Pneubiggin and the 9 o'clock Pnews. Ptolemy was not a member of the Royal House which indulged in orgies all over Egypt from 323 to 30 B.C. and his name is not in Debrett or the New York Social Register. Despite this handicap he triggered off Trig. which had got off to a rather slow start after its discovery by Hipparchus 250 years earlier. Ptolemy's natural elation gave rise to the phrase "Trigger Happy". Trigonometry is mainly a matter of sines, v-sines, co-sines, co-eds, and chords. Somewhere along the line the chord got lost. Trigonometry is strictly mathematical but hasn't got much to do with counting machines which this advertisement is really about.

This is C.I.'s In-line Pdigital Pdisplay Unit which projects any number from 1 to 12, or any combination of letters, symbols or fractions, in white or colour, 3½" high on to a screen for one plane presentation. Between ourselves, Ptolemy would have agreed it gives quite a ptolerable performance!



series 640
LARGE IN-LINE
DIGITAL DISPLAY

COUNTING INSTRUMENTS LTD · ELSTREE WAY · BOREHAM WOOD · HERTS · Tel: ELStree 4151
wh

EE 40 052 for further details

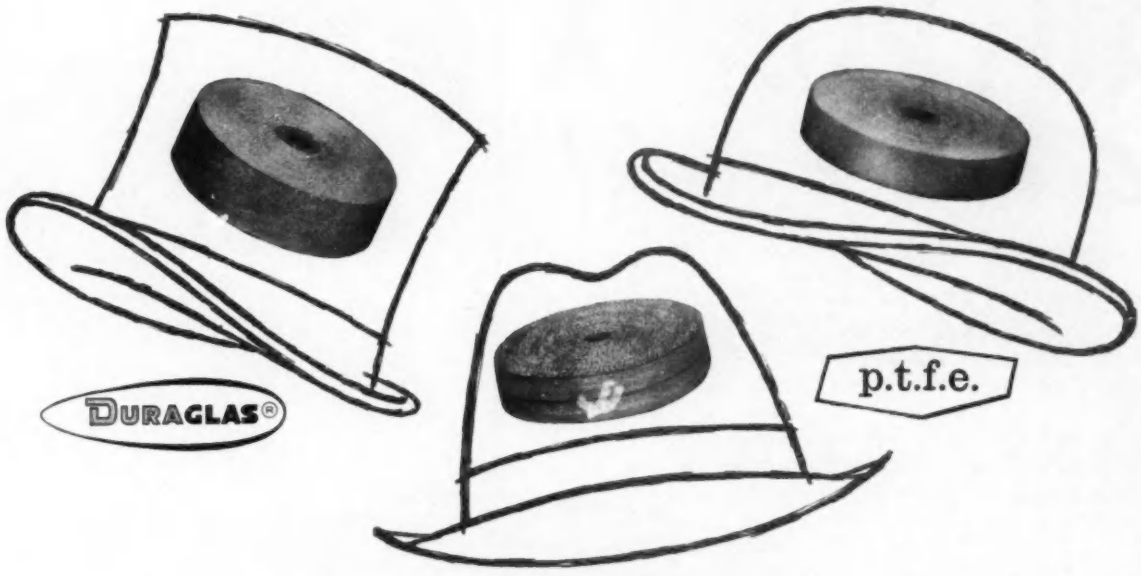
Making the RIGHT CONTACT

Behind the button, the contact; sometimes a single pair, sometimes a whole complex array. Every time the button is pressed the contacts must make or break, reliably, under a wide range of operating conditions, in which resistance to excessive wear, arcing, welding or corrosion is most important.

Making the right contact, one which is perfectly suited to the job, is vital. "Thessco" and "Thessconite" contact materials and assemblies are backed by long experience —and success. Our latest catalogue gives details of contacts we manufacture.

The SHEFFIELD SMELTING COMPANY LIMITED

HEAD OFFICE AND WORKS: ROYDS MILL STREET, SHEFFIELD, 4.
ALSO AT LONDON AND BIRMINGHAM.



PYROFLEX®

Three's good company . . .

"Duraglas" Glass-fibre Tapes have many applications within the electrical insulation field such as conductor insulation, coil wrappings, core bindings, mechanical reinforcements, cable wrappings, and heat resistant protective coverings.

"Pyroflex" Asbestos Listing Tape has been specially designed for the electrical industry. "Pyroflex" is manufactured from carefully selected and purified fibres, and is suitable for a wide range of electrical insulation applications.

p.t.f.e has exceptionally good dielectric properties, is non-tracking, non-flammable, resistant to moisture and totally unaffected by weathering conditions. As a result it has a wide application in the electrical industry in the form of tape for the insulation of cables, motors and transformers.

with **TURNERS**

Electrical Insulation Tapes

TURNER BROTHERS ASBESTOS CO LTD ROCHDALE ENGLAND

A MEMBER OF THE **TURNER & NEWALL** GROUP

TA 269

EE 40 054 *for further details*

AUTRONEX
Acid Gold

A Hard Bright Gold for the most exacting industrial applications — a mildly acid solution—plating at room temperature with absolutely no free cyanide.

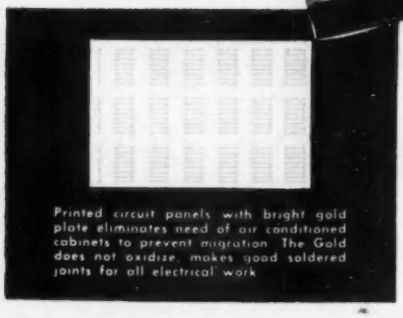
Ideal process for semi-conductor devices with electronic equipment—ranging from ballistic missiles to office data processing machinery.

Newest and fastest computor systems for business and scientific use, utilise printed circuit boards plated with AUTRONEX Acid Gold.

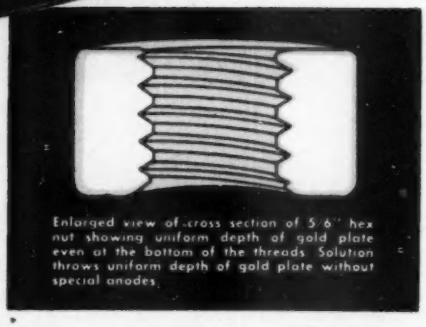
Some of the Advantages are :—

1. **Harder and more wear-resistant surfaces.**
2. **Elimination of gold strike.**
3. **Promotion of higher bond strength of circuit to dielectric base material (no damage to adhesive layer).**
4. **Elimination of circuit lifting or rejects on boards plated after etching.**

Obtain details and have samples processed in our Pilot Plant.



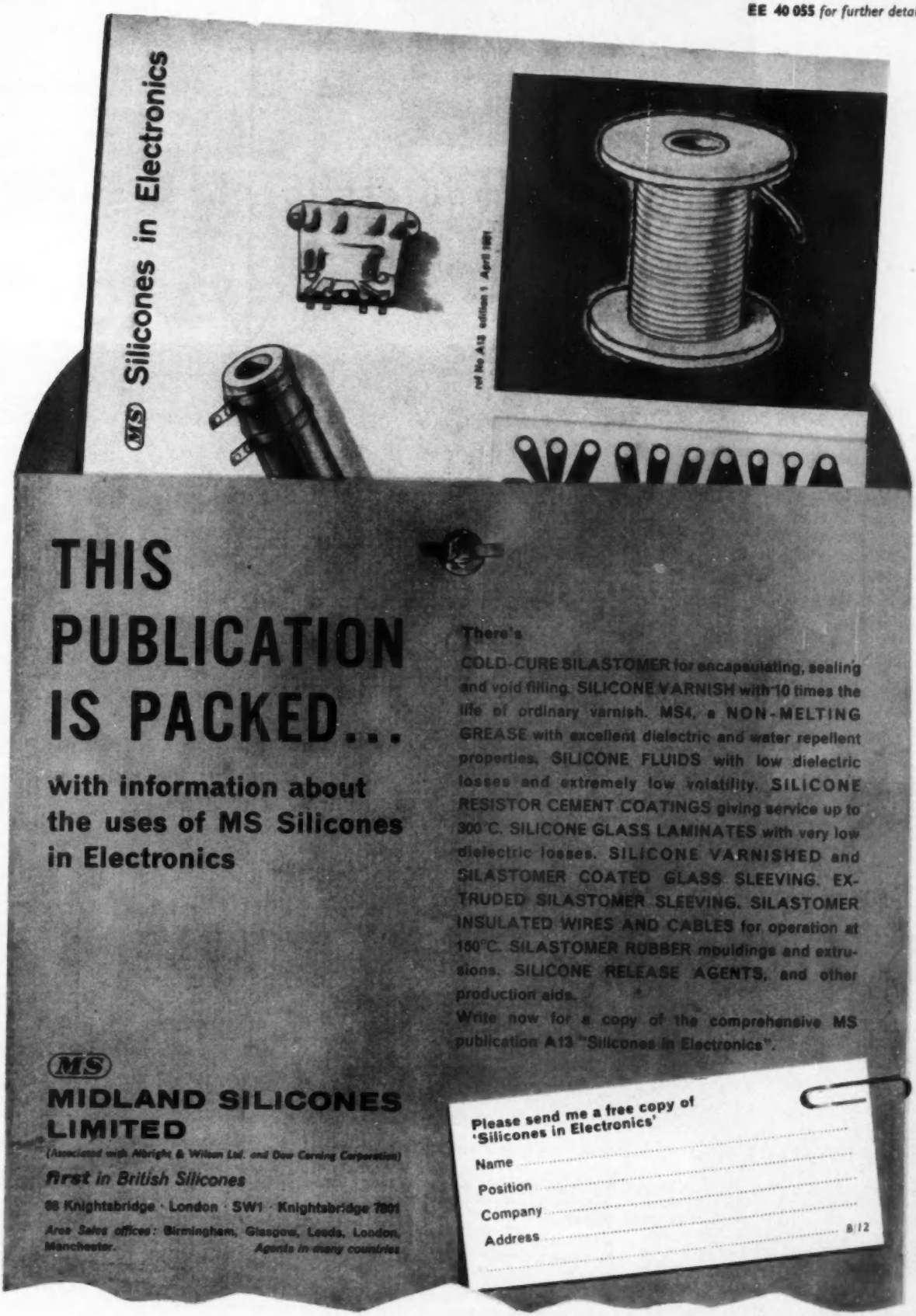
Printed circuit panels with bright gold plate eliminates need of air conditioned cabinets to prevent migration. The Gold does not oxidize, makes good soldered joints for all electrical work.



Enlarged view of cross section of 5/6" hex nut showing uniform depth of gold plate even at the bottom of the threads. Solution throws uniform depth of gold plate without special anodes.

Sel-Rex

M. L. ALKAN LTD. STONEFIELD WAY - VICTORIA ROAD - RUISLIP - MIDDLESEX
'Phone: VIKING 3301 (4 lines)
Offices in BIRMINGHAM · BRISTOL · BURNLEY



THIS PUBLICATION IS PACKED...

with information about the uses of MS Silicones in Electronics

There's

COLD-CURE SILASTOMER for encapsulating, sealing and void filling. SILICONE VARNISH with 10 times the life of ordinary varnish. MS4, a NON-MELTING GREASE with excellent dielectric and water repellent properties. SILICONE FLUIDS with low dielectric losses and extremely low volatility. SILICONE RESISTOR CEMENT COATINGS giving service up to 300°C. SILICONE GLASS LAMINATES with very low dielectric losses. SILICONE VARNISHED and SILASTOMER COATED GLASS SLEEVING. EXTRUDED SILASTOMER SLEEVING. SILASTOMER INSULATED WIRES AND CABLES for operation at 150°C. SILASTOMER RUBBER mouldings and extrusions. SILICONE RELEASE AGENTS, and other production aids.

Write now for a copy of the comprehensive MS publication A13 "Silicones in Electronics".

MS

MIDLAND SILICONES LIMITED

(Associated with Albright & Wilson Ltd. and Dow Corning Corporation)

first in British Silicones

66 Knightsbridge · London · SW1 · Knightsbridge 7801

Area Sales offices: Birmingham, Glasgow, Leeds, London, Manchester. *Agents in many countries*

Please send me a free copy of 'Silicones in Electronics'

Name .....

Position .....

Company .....

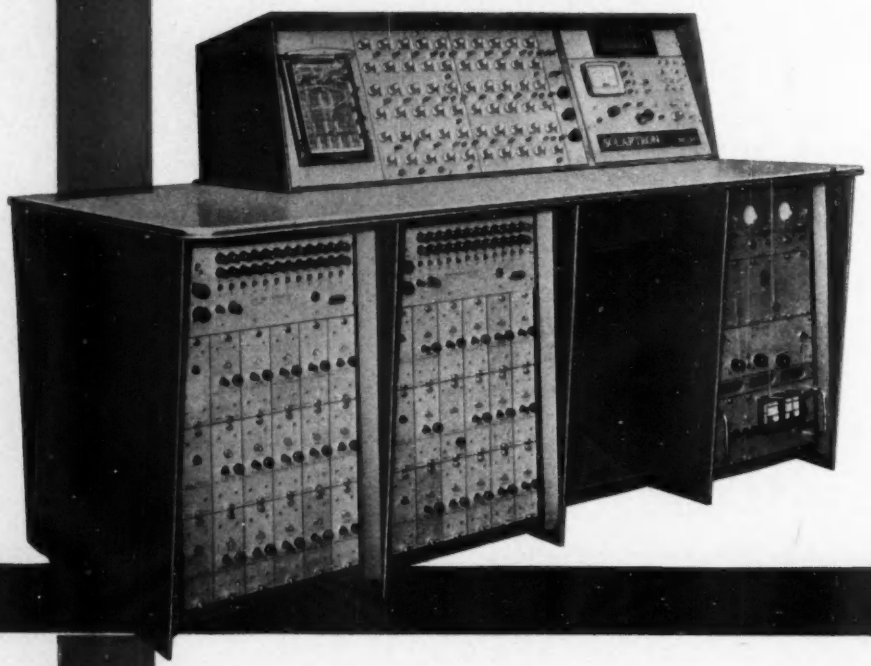
Address 8/12

MSE 30

SOLARTRON

analogue computers for DESIGN

—simulating and solving the dynamic problems of a system prior to construction.



Analogue Computer 'S.C. 30'

The S.C. 30 combines high accuracy, high work loading factor, comprehensive central control and programming facilities, together with outstanding overall flexibility. It will provide accurate solutions for a wide range of linear and non-linear dynamic problems.

★ 30 operational amplifiers.

★ High performance non-linear units are incorporated.

★ A high accuracy automatic timing device is included with facilities for repetitive operation.

★ Manual or automatic decade scale changing facilities provided.

★ 5-Figure Digital Voltmeter and high accuracy reference supply ensures rapid and accurate programming.

★ A detachable problem board allows problem storage and simple patching.

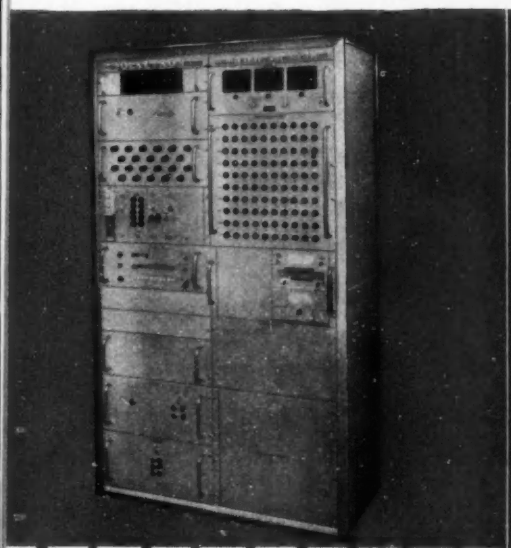
SOLARTRON

Special Digital Data Recorder systems can be supplied for automatic plant supervision, to provide continuous monitoring of parameters with off-limit detectors to keep industrial processes within normal operating limits. Outputs can be recorded on punched paper tape, in-line printer, typewriter or magnetic tape.

Special 400 Channel Digital Data System installed in a large European Power Station.

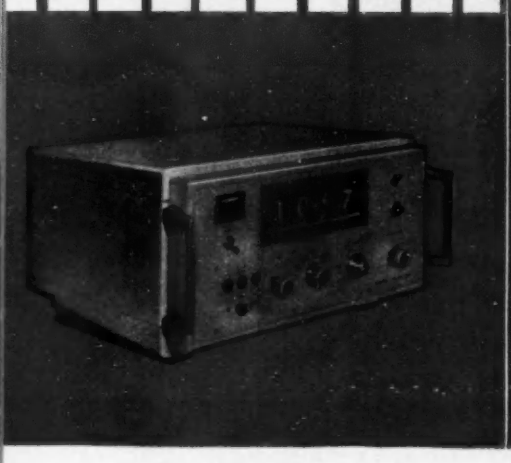
digital data recording systems for **MEASUREMENT AND CONTROL**

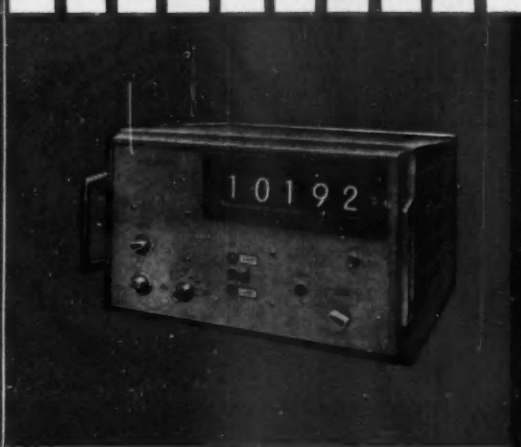
—of industrial plants and processes.



★ HIGH GAIN
★ LOW DRIFT
★ LOW NOISE

Gain: 20 x to 1000 x in 10 steps, with continuous 1 to 2 x variation on each step. (D.C.—40 kc/s)
Drift: 2 μV in 40 hours
Z_{in}: 100 kΩ
Z_{out}: 1 Ω in series with 25 μH
Output: $\pm$ 35 Volts into loads > 1 kΩ, $\pm$ 35 mA pk.





SOLARTRON Electronic Equipment

comprises precision built units of high accuracy and reliability, designed to function either as complimentary units in large installations, or to operate as independent instruments in Production, Research or Development work.

4-Figure D.C. Digital Voltmeter LM 902.2
★ 100 μV to 1.599 kV (in 5 ranges)
★ Accuracy $\pm$ 0.1% of full scale on each range.
★ Automatic polarity discrimination.
★ 280 milliseconds Read-out Time.
★ Adjustable 'Dead Zone' to eliminate jitter.

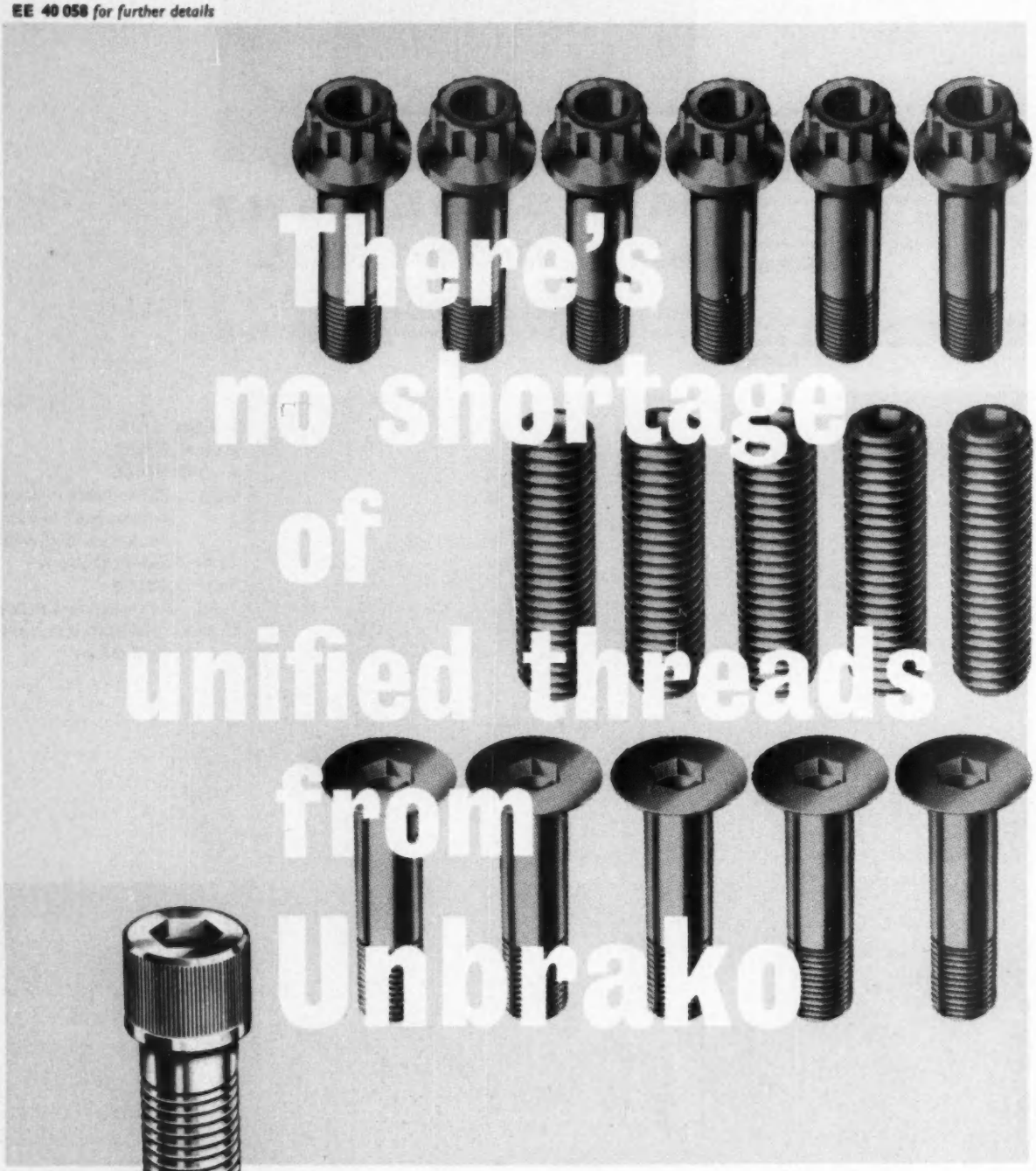
5-Figure D.C. Digital Voltmeter LM 1010
★ 0–0.15998 V to 0–1.5999 kV (in 5 ranges)
★ Accuracy 0.05%. Resolution 0.01%. (Max. 20μV)
★ 1000 MΩ input impedance, suitable for capacity transfer techniques.
★ Up to 60 conversions/sec.
★ Direct Reading Thermocouple Ranges.

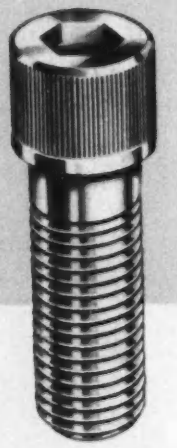
For full details of the Solartron range of electronic instruments and equipment, write to any of these addresses–

W. GERMANY Solartron Elektronik GmbH, Munich 15. *Tel:* Munich 59.51.09 ● **HOLLAND** Solartron (Nederland) N.V., The Hague. *Tel:* The Hague 543147 ● **ITALY** Solartron S.p.A., Milan. *Tel:* Milan 412 396 ● **SWEDEN** A.B. Solartron, Stockholm NO. *Tel:* Stockholm 600906 ● **FRANCE** Solartron France S.A., Paris 20e. *Tel:* Pyrenées 4840 ● **UNITED STATES** Solartron Inc., Anaheim, California. *Tel:* Prospect 2-2652 *There are Solartron agents throughout the world.*

The Solartron Electronic Group Limited, International Division, Cox Lane, Chessington, Surrey, ENGLAND. Telephone: LOWer Hook 5252 Cables: SOLARTRON CHESSINGTON Telex: 23842 SOLARTRON CHESS.

EE 40 058 *for further details*

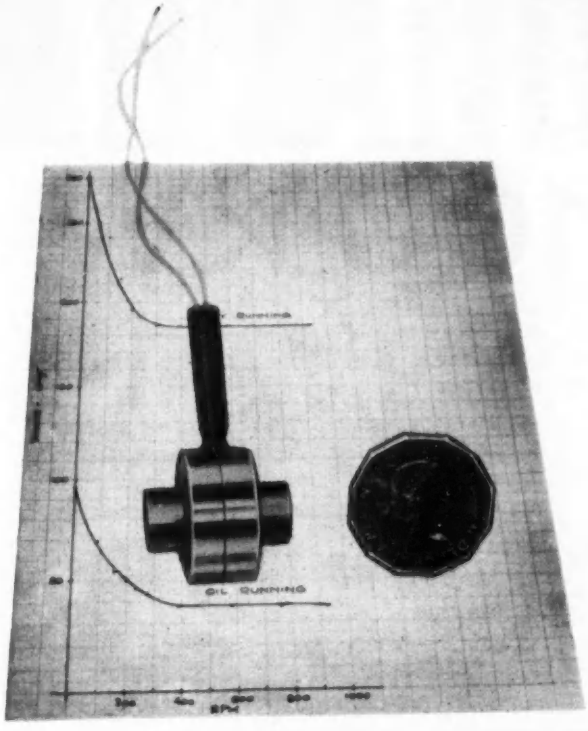




UNBRAKO

Unbrako, the world's largest suppliers of high grade socket head screws, can give instant delivery from their vast standard range covering all types and threads including unified. Whatever your fastener requirements, Unbrako can deliver the goods on time.

UNBRAKO SOCKET SCREW CO LTD COVENTRY TEL: 88722



down to the minute

For problems of torque transmission in minimum space, Crofts now have the answer with a new magnetic clutch no bigger than a threepenny bit.

This new addition to the range of Crofts magnetic instrument clutches will have innumerable applications in the fields of instrumentation, electronics and nucleonics. It is one more instance of Crofts' perennial leadership in power transmission of all magnitudes.

Send for PUBLICATION No. 6013A

CROFTS (ENGINEERS) LIMITED

POWER TRANSMISSION ENGINEERS

THORNBURY BRADFORD 3 YORKSHIRE

Telephone: 65251 (20 lines). Telegrams: 'Crofters Bradford Telex'. Telex: 51186.
Branch Offices . . . BELFAST, BIRMINGHAM , BRISTOL, CARDIFF, DUBLIN GLASGOW , IPSWICH, LEEDS , LIVERPOOL, LONDON , MANCHESTER , NEWCASTLE, NORTHAMPTON, NOTTINGHAM, SHEFFIELD, STOKE-ON-TRENT.
**Stockholding branches.*

EE 40 060 *for further details*

INDUSTRIAL R.F.
UP TO 100 kW

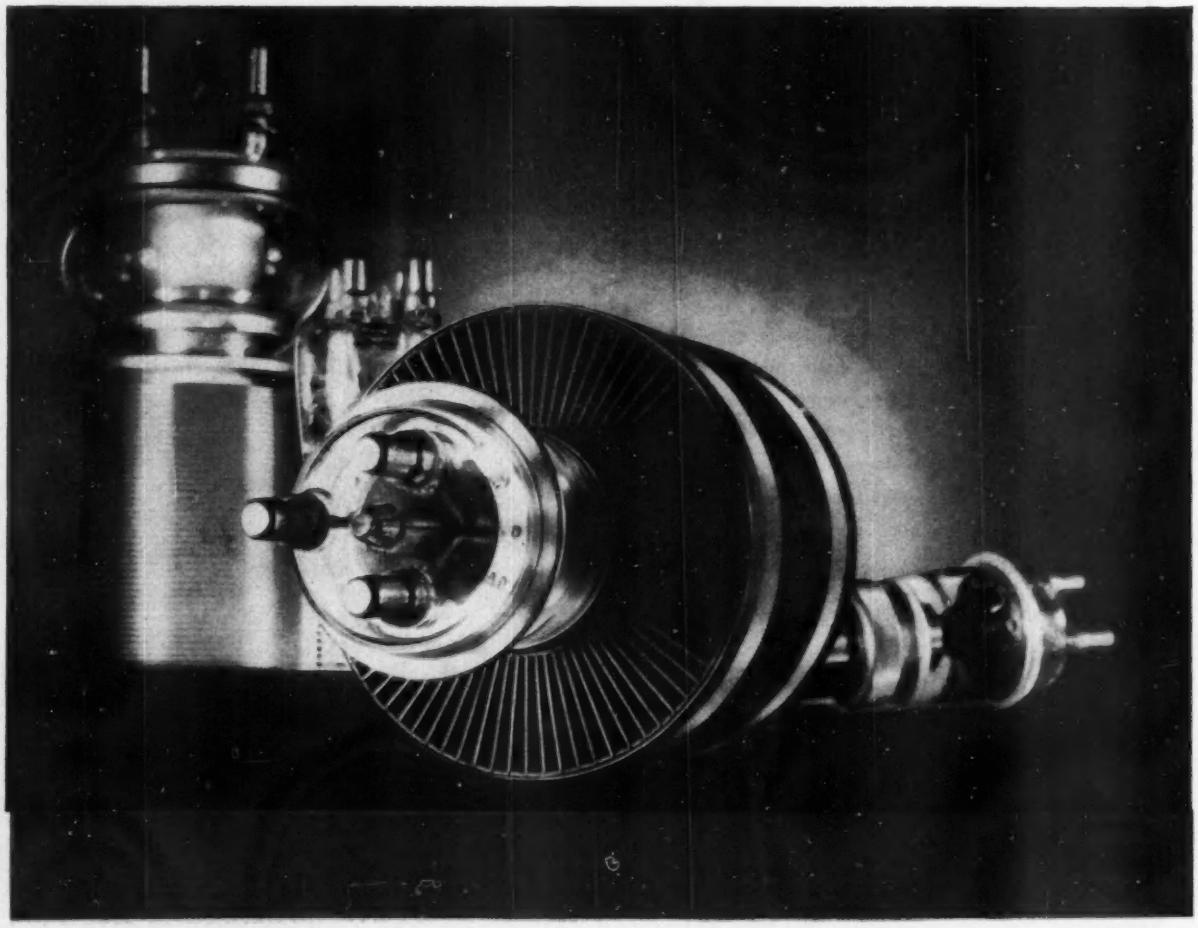
Mullard R.F. Heating Valves cover the power range up to 100 kW, in air and water cooled versions. Five basic valves have been especially designed to meet the requirements of industrial r.f. heating power levels. Each valve is mechanically and electrically robust, and will operate with extreme reliability under varying load conditions, fluctuating mains voltage and mechanical vibration.

Constant Power . . . three of the new series are designed so that output power is substantially independent of load impedance.
The electrical characteristics of these three types have been specially designed to maintain the output power close to nominal over load variations of 3 to 1.

Filaments . . . are made of heavy duty thoriated tungsten, generously rated to provide an adequate reserve of emission—and to accept temporary voltage variations of +5% and −10% of the nominal.

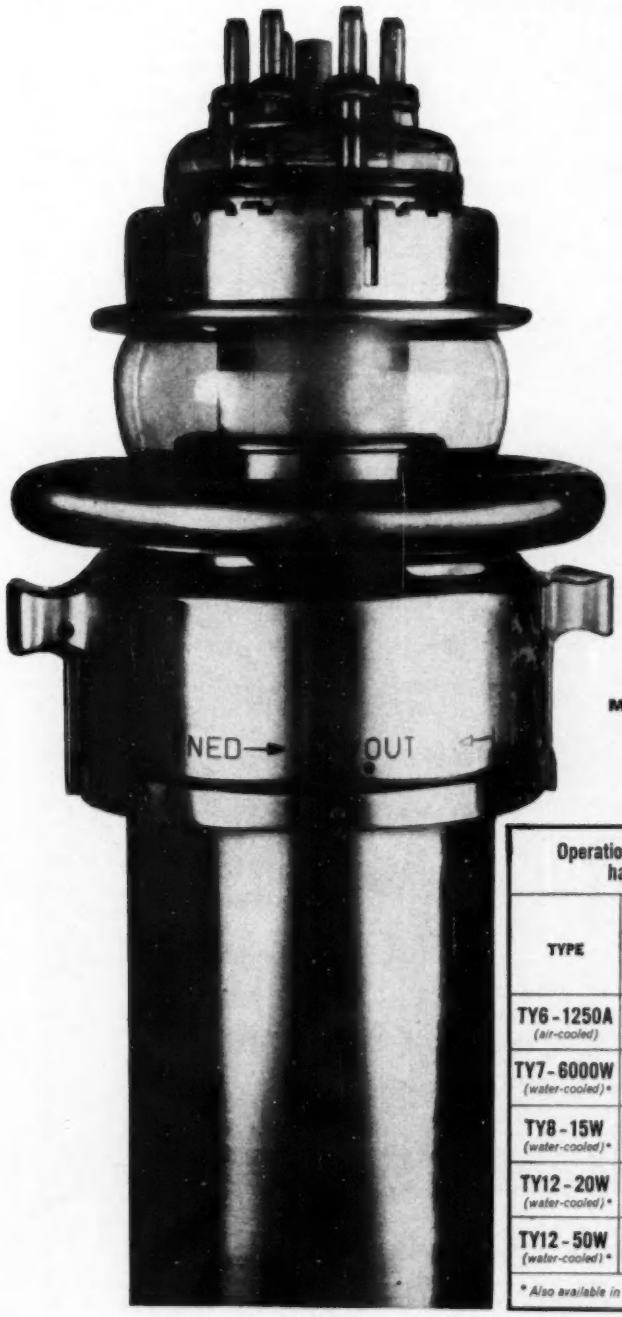
Grid . . . special material and processing give the valves long life under arduous conditions.

Anodes . . . are designed to withstand accidental overdissipation.



EE 40 061 *for further details*

HEATING VALVES



The data presented in this advertisement gives only an outline of the characteristics and performance of the Mullard High Power Range of Industrial R.F. Heating Valves; full details including special high frequency operating conditions are available on request. Please quote reference D41612 in your correspondence.

Mullard

GOVERNMENT AND INDUSTRIAL VALVE DIVISION

MULLARD LIMITED
Government & Industrial Valve Division
Mullard House, Torrington Place, London W.C.1

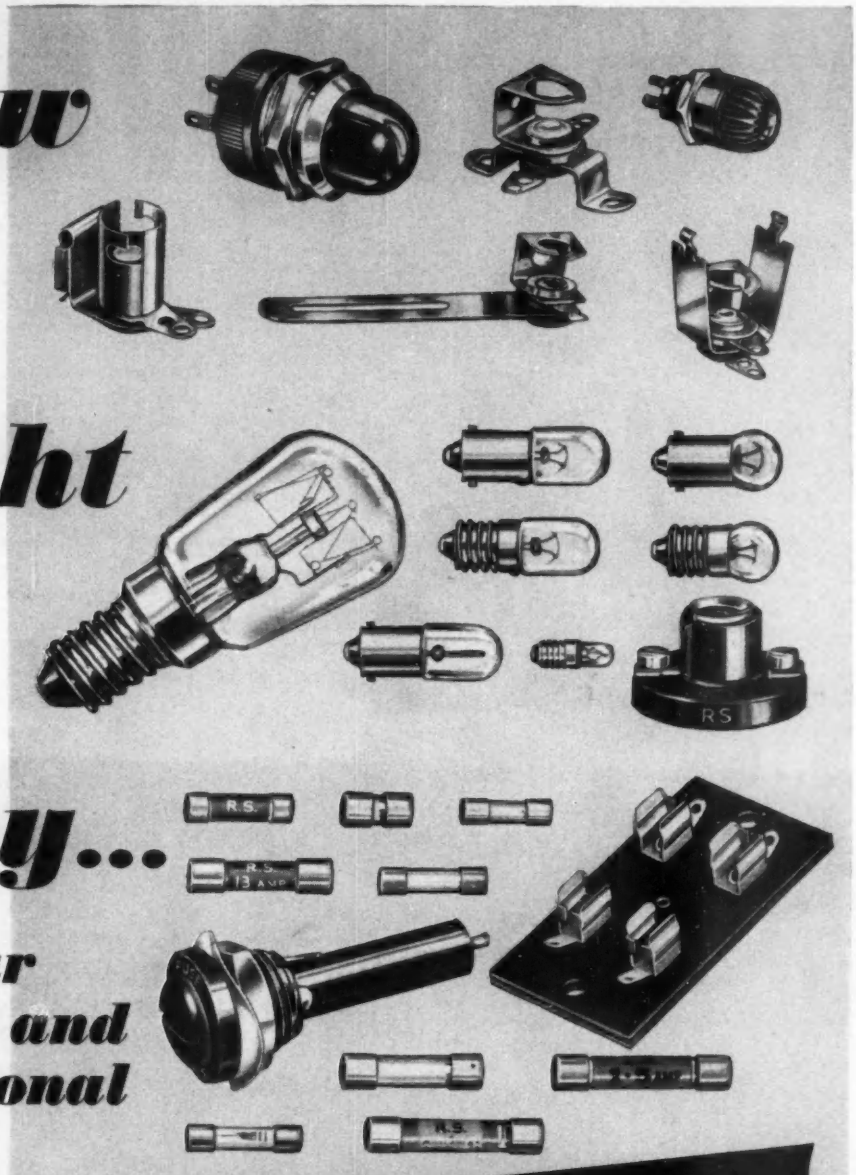
Operation for anode voltage obtained from three-phase half-wave rectifier without smoothing filter								FILAMENT CHARACTERISTICS	
TYPE	LIMITING VALUES				CONTINUOUS OPERATION				
	pa max (kW)	Va max (kV)	Ik max (A)	f max (Mc/s)	Pout (kW)	f (Mc/s)	Vtr (r.m.s.) (kV)	Vf (V)	If (A)
TY6-1250A *(air-cooled)*	1·3	7·0	2·0	50	4·0	50	5·1	6·3	65
TY7-6000W *(water-cooled)**	6·0	7·0	2·3	55	6·0	50	5·1	12·6	33
TY8-15W *(water-cooled)**	15	8·0	5·5	30	17·7	30	5·9	6·3	130
TY12-20W *(water-cooled)**	20	13	6·3	30	39	30	8·9	8·0	130
TY12-50W *(water-cooled)**	50	15	15	30	100	30	—	17·5	196

** Also available in air-cooled versions*

MVTC 414

EE 40 062 *for further details*

Throw a Light Safely...



on all your prototype and constructional problems

Use RADIOSPARES Quality Components

'BY RETURN' DELIVERY SERVICE OF GUARANTEED ELECTRONIC COMPONENTS

Consult our catalogue for all types of Pilot Lamps, Lamp Holders, Fuses and Fuseholders

Radiospares Ltd.

4-8 MAPLE STREET · LONDON · W1 · ENGLAND

Telephone: EUSton 7232 (8 lines)

TELEGRAMS: RADOSPERES, WESDO, LONDON *CABLES:* RADOSPERES, LONDON—W1

specify

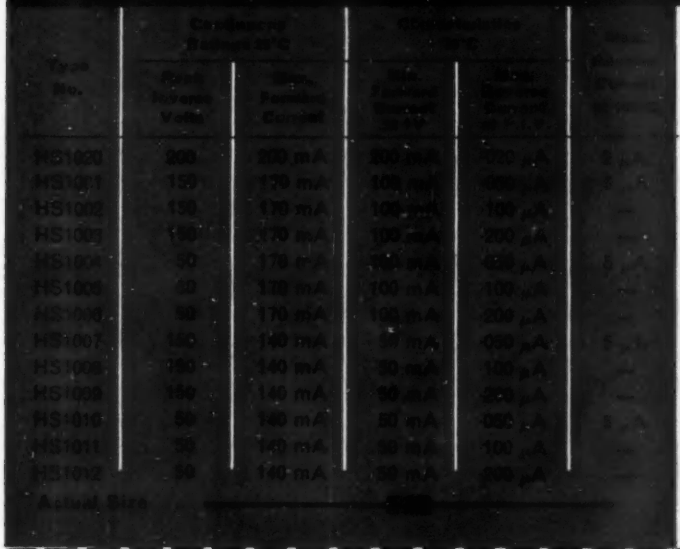
diodes

Hughes HS10 series are low cost alloyed junction silicon diodes characterized by good forward conductance and low reverse current at high temperatures.

Made in Glenrothes, Scotland, the Hughes range of silicon and germanium diodes are subminiature devices with extremely stable electrical and mechanical characteristics. These diodes are specially designed and constructed to meet the most exacting requirements of military or commercial applications. They are double wire ended and fusion-sealed in a subminiature one-piece glass envelope to ensure complete isolation of the active elements from damage or contamination. The small size, combined with rigidity of construction and small mass of the elements, enable them to withstand successfully physical shock and vibration.

LOW REVERSE LEAKAGE + SMALL SIZE + DOUBLE ENDED + LOW CAPACITANCE

+ RELIABILITY + IMMEDIATE AVAILABILITY + LOW COST = **HS10** SERIES

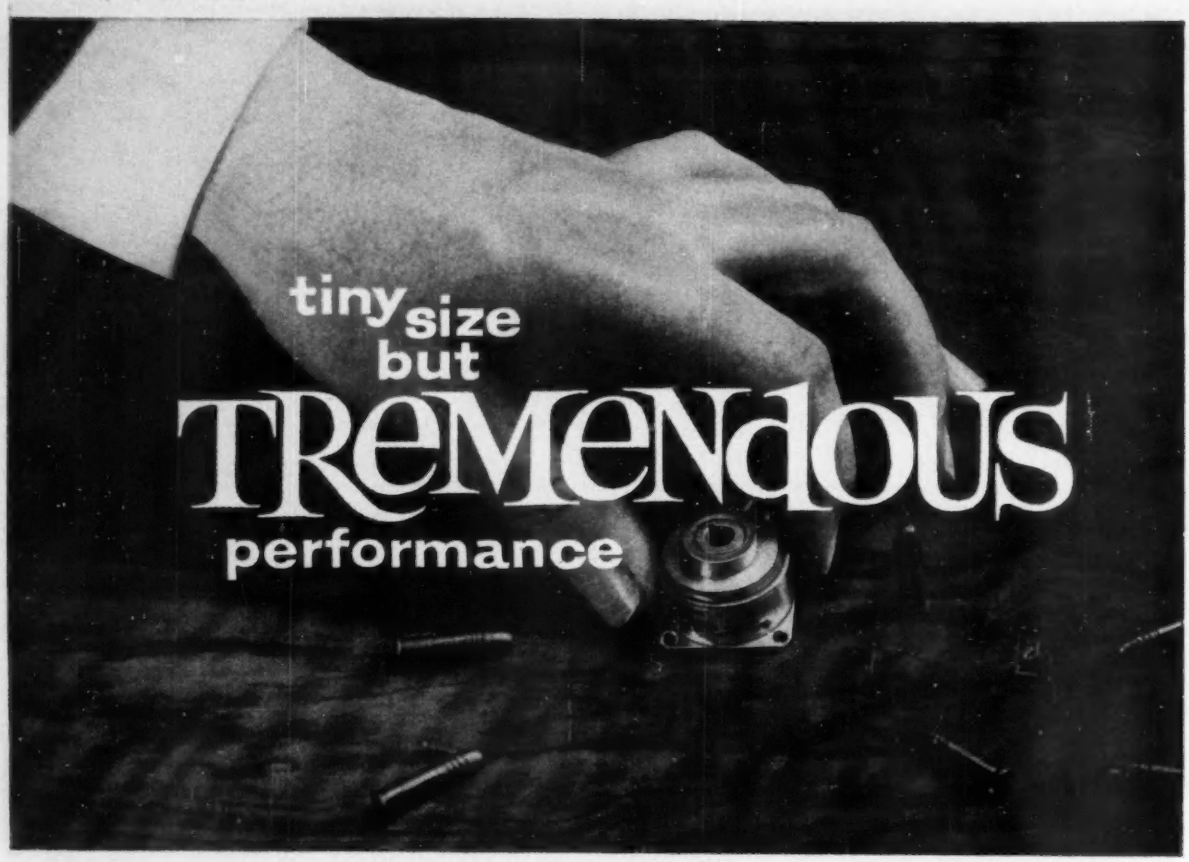


Qualified engineers in our Research and Development laboratories at Glenrothes are available to help with your application problems.

Home and overseas enquiries to:

HUGHES INTERNATIONAL (U.K.) LTD

KERSHAW HOUSE, GREAT WEST ROAD, HOUNSLOW, MIDDLESEX · HOUNSLOW 5222



Just the size of a penny, but with a clutch performance out of all proportion to its size. That's the Warner *miniature* electromagnetic clutch (or clutch coupling).

This $1\frac{1}{8}$ in. diameter unit, the SF 100, transmits a maximum torque of 2 lb. in. *Its response time is only a few milli-seconds.* With a power rating of no more than 6 watts, the SF 100 achieves a speed of 15,000 r.p.m.

The advantages of Warner *miniature* electro-magnetic clutches are clear and considerable, particularly when these units are incorporated in control mechanism on light instrument drives, computers and servo systems.

Ask your secretary to write for details of the SF 100—the tiny unit with the tremendous performance.

WARNER

Electric Miniature Clutches

Complete technical information of the Warner range on request

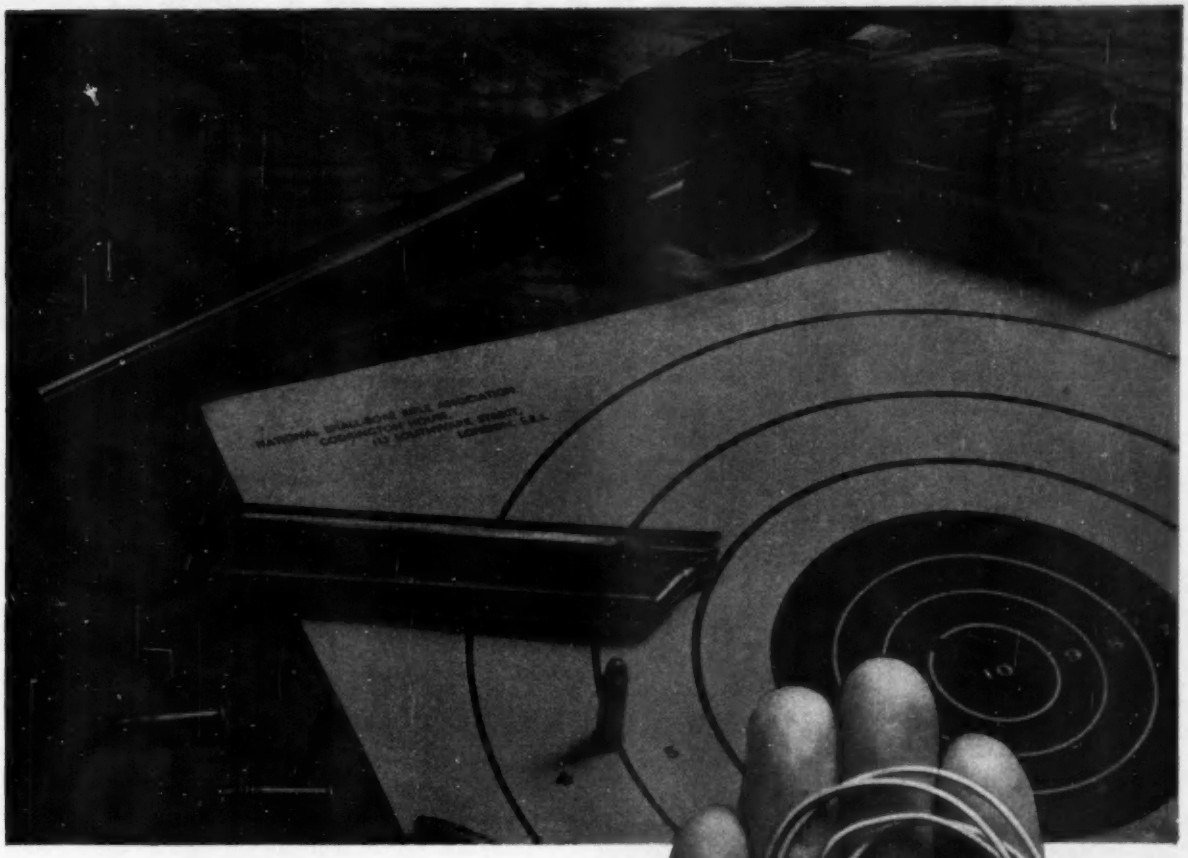
WESTOOL LTD., ST. HELEN'S AUCKLAND, CO. DURHAM.

Telephone: West Auckland 551 (6 lines)
Telegrams: Solenoid, West Auckland

London Office: 2 Ashley Place, Carlisle Place, S.W.I. Tel: Victoria 7301/2

Birmingham Office: Silhill House, 2241 Coventry Rd., Sheldon, Birmingham 26. Telephone: Sheldon 5121/2.

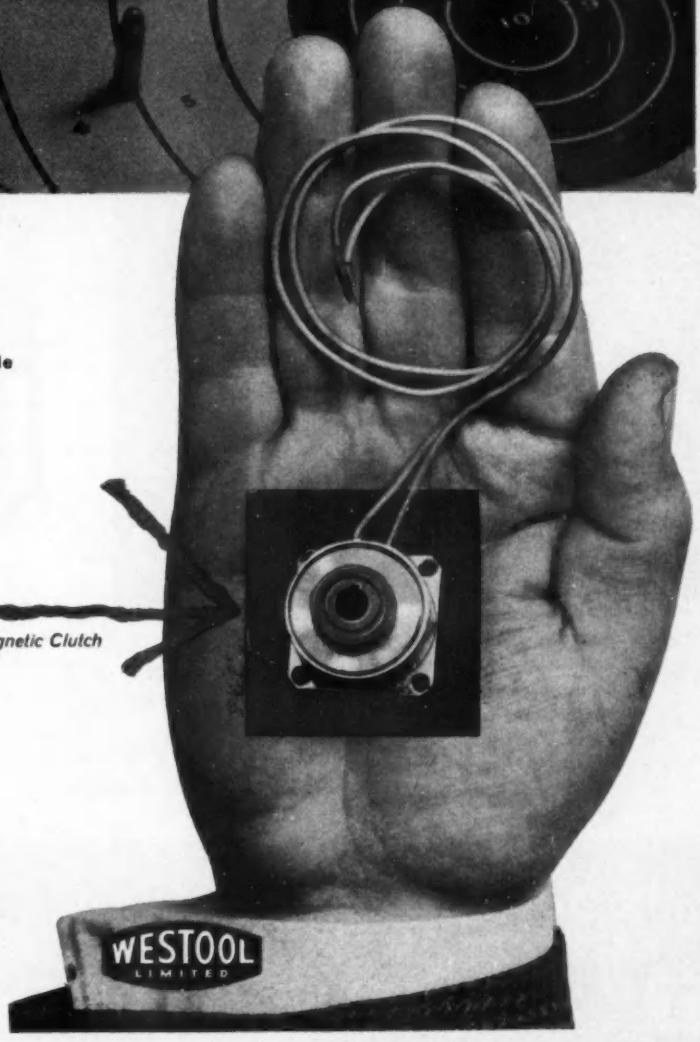
TIB 198



OF COURSE, NOT ONLY MINIATURE

The Warner range of electric brakes and clutches meets the needs of all types of industrial machinery. Modification of standard units can be made to satisfy special requirements. Warner electric motion control is the most advanced, practical method of linking together mechanical functions with electric controls. It offers almost limitless possibilities for improvement in machine designs, and adds greatly to the performance of existing models.

Warner SF 100 Electro-Magnetic Clutch



SPECIAL ANNOUNCEMENT

Maximum torque up to 1350 lb. ft. now available for Warner Units

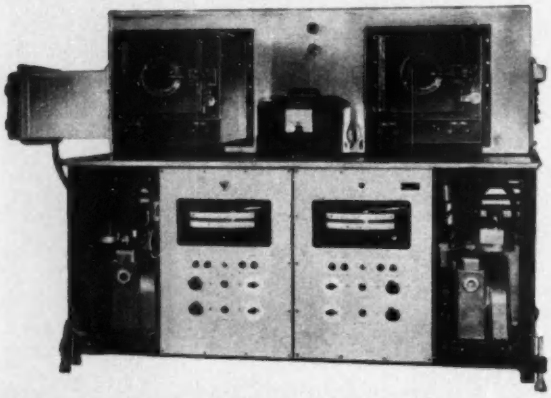
EE 40 066 *for further details*

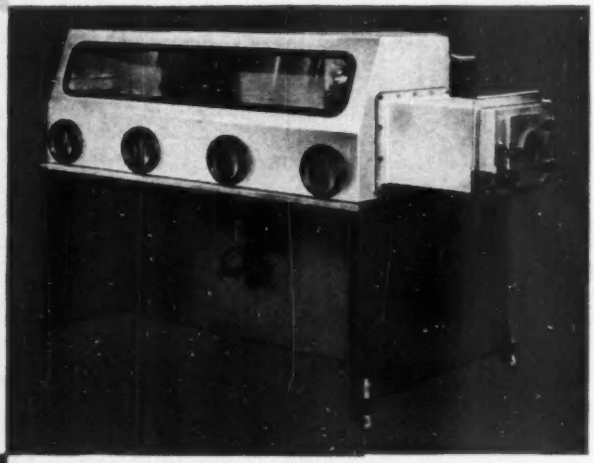
DOUBLE ENDED STAINLESS STEEL VACUUM OVENS

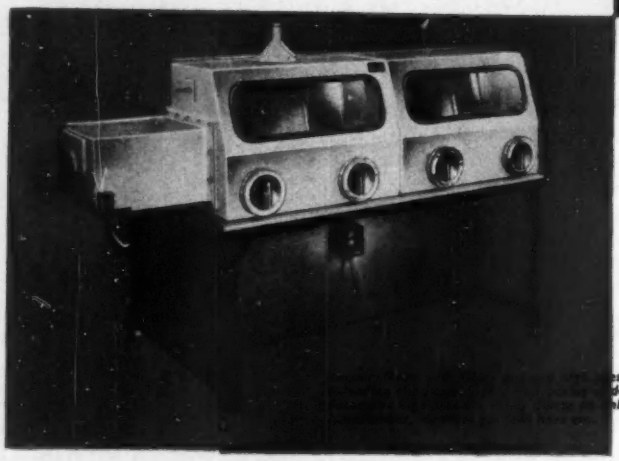
with glove box for semiconductor devices

We design and manufacture Ovens to Customers' special requirements. Should you have any problems in this field our Technical Department is always willing to help you solve them. Vacuum Ovens with temperatures of up to 600°C are also manufactured by us on similar lines but with Sectional Heating and Water-Cooled Ends.

We design, manufacture and supply Vacuum Machinery to major companies in Great Britain and Overseas.







Made throughout in polished stainless steel.
Single action door openings.
Rectangular with self spacings to suit.
Double-ended controls.
Electrical interlocking of air inlet and isolation valve.
Outer cover hermetically sealed.
Temperature Range 0-400 C.
or equivalent F

Temperature Control: Normal ±7½°C. Special ±1°C.
Internal Spacing 7" x 8" x 18".
(can be altered to special requirements).
Vacuum Range: To 10^{-4} m.m.
Respective Vacuum Gauges incorporated.
Automatic air inlet valve on Backing Pump.
Visual Indicators and Fuses on all switches.
Flanged for fitting into Dry Box.

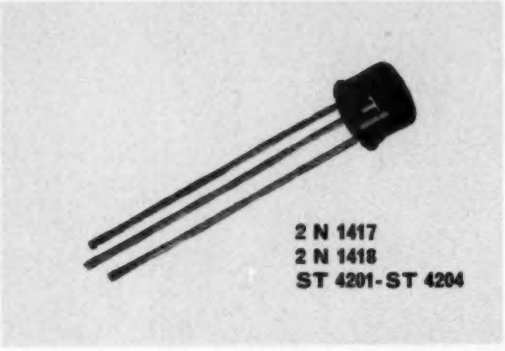
VACWELL ENGINEERING CO., LTD.

WILLOW LANE · MITCHAM · SURREY Tel: MITcham 8211 (3 lines)

VACWELL ENG. CO. LTD.

only Transitron offers

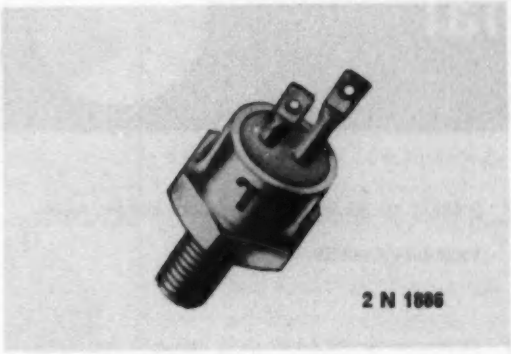
INDUSTRIAL SILICON TRANSISTORS FOR EVERY POWER RANGE



2 N 1417
2 N 1418
ST 4201-ST 4204

In the small signal and medium power range, these high-quality devices are designed for switching and amplifying applications in the commercial and industrial field. Low cost makes them ideal for germanium replacement where low collector currents are desired.

Intermediate power, 2 ampere transistors feature good beta linearity over the range of 50 ma to 2 amperes collector current. Suitable for use in all applications including voltage regulators, servo-amplifiers, power output stages, and high power transistor drivers.



2 N 1886

ST 7120

High power, 5 ampere transistors feature low saturation voltage and low leakage currents, making them the preferred transistors for power supply and converter applications. High temperature reliability is assured by extensive conditioning, performed as a regular part of the manufacturing process.

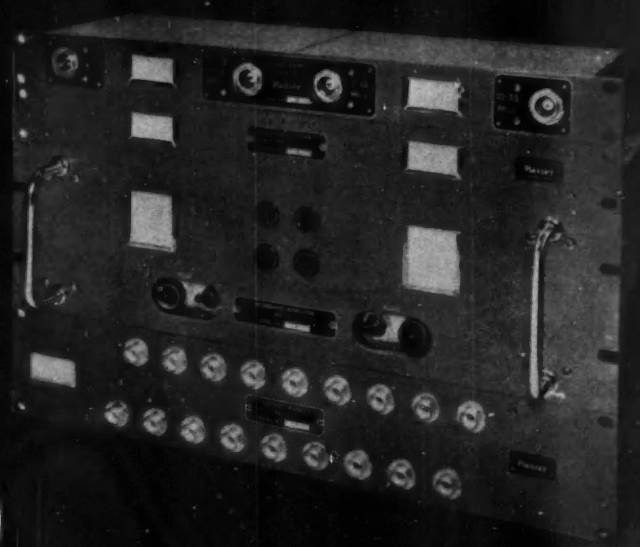
Quick delivery anywhere in the United Kingdom.
Details on request from

TRANSISTORS · DIODES · RECTIFIERS · SWITCHES · REGULATORS · REFERENCES

Transitron electronic limited
BILTON HOUSE UXBRIDGE ROAD LONDON W5
Telephone EALing 8042

Plessey

Aerial Exchange feeds 80 receivers from one aerial

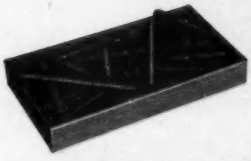


- 2 Mc/s to 30 Mc/s overall coverage; uses four basic units.
- Optional additional units link any receiver to any of several arrays.
- Standard unit range speeds maintenance, simplifies installation.
- Complete system gives ultimate capacity of 80 receivers working to 12 aerial arrays.
- Electronic switching minimises noise, heightens long-term reliability.
- Zero overall insertion loss; high-gain, low-noise wideband amplification.
- Easily arranged for dual-diversity working.

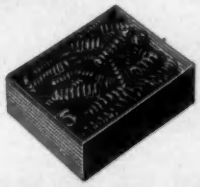
Comprehensive details of this flexible range of equipment are available on request.

Telecommunications Division · Electronic and Equipment Group
THE PLESSEY COMPANY LIMITED · Ilford · Essex · Ilford 3040
Overseas Sales Organisation: Plessey International Limited

EXPERIMENTAL SPRINGS?

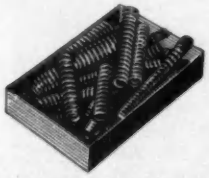


No. 1200. Three dozen Assorted Light Expansion Springs, suitable for carburettor control, etc. **15/-.**

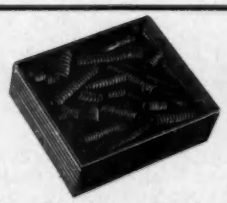


No. 98A. Three dozen Assorted 1" to 4" long, ¼" to ⅜" diam., 19G to 15G. **6/6.**

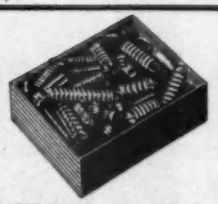
No. 753. Three dozen Assorted Light Expansion ¼" to ½" diam., 2" to 6" long, 22 to 18 S.W.G. **12/-.**



No. 760. Three dozen Assorted Light Compression Springs. 1" to 4" long, 22 to 18 S.W.G., ¼" to ½" diam. **7/6.**



No. 757. Extra Light Compression, 1 gross Assorted, ½" to ⅞" diam., ½" to 2½" long, 27 to 19 S.W.G. **18/-.**



No. 758. Fine Expansion Springs. 1 gross Assorted ¼" to ½" diam., ½" to 2" long, 27 to 20 S.W.G. **18/-.**

That spring you want . . . in a hurry . . . *where* is it? Pick *what* you want *when* you want it from TERRY'S BOXES OF ASSORTED SPRINGS—our fine range of small boxed assortments of experimental springs. We can show you only a few from the range here. Send a postcard for our full list—and if ever you're stuck with a spring problem send it along to our Research Department —they'll gladly help you out.

Have you a Presswork problem?

If so, the help of our Design Staff is yours for the asking.

TERRY'S *for SPRINGS*

Really interested in Springs? "Spring Design and Calculations" 10th Edition tells all—post free 12/6.

Cut Production Costs with Terry's Wire CIRCLIPS. We can supply immediately from stock—from ¼" to ½".

Looking for good Hose Clips? Send for a sample of Terry's Security Worm Drive Hose Clip and price list.

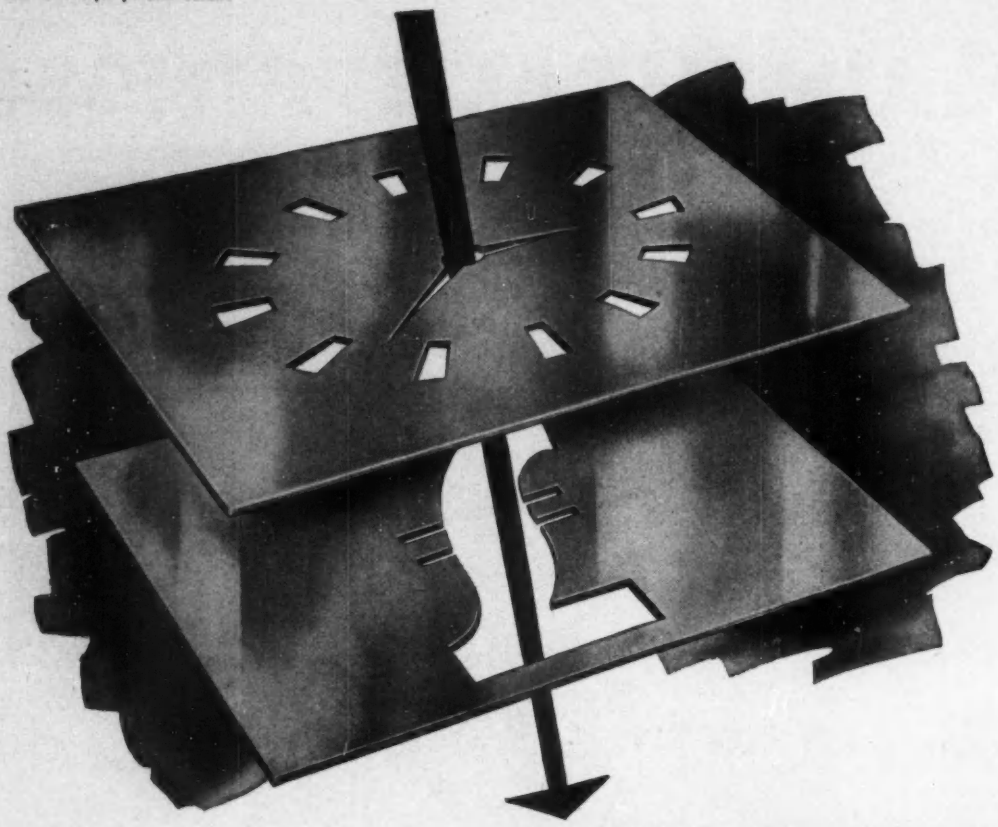
HERBERT TERRY & SONS LTD

Redditch, Worcs.

(Makers of Quality Springs, Wireforms and Presswork for over 100 years)

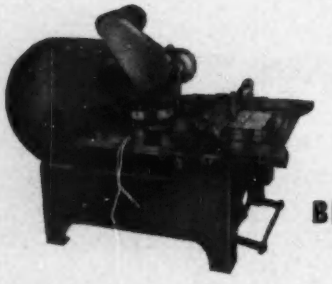
HT31

EE 40 070 *for further details*



WIEDEMANN

pierces the Time and Cost Barrier....



Wiedemann cuts the cost of short and medium run piercing by as much as 85% and does the job much better and much faster. No more marking out—No more setting up, drilling, flycutting, chiselling out or finishing to size and *no more costly tooling.* Modifications or complete changes of layout made quickly, easily, cheaply.

Write for Wiedemann Brochure No. EE/176 and study the 'hole' time and cost question—and send sketches of some of your jobs and ask for time studies.

BRITISH WIEDEMANN TURRET PUNCH PRESSES

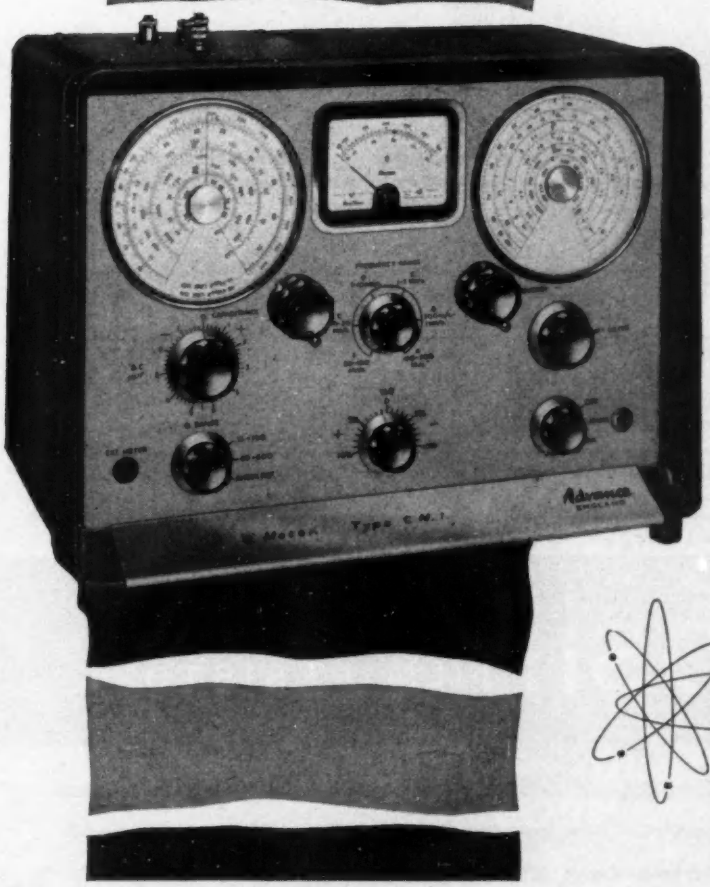
RA.-41P with pantograph table and stylus for rapid hole location. Throat depth 28" with 16, 18 or 20 turret stations. 30,000 lbs. capacity. Other models—hand and power operated—15,000 to 160,000 lbs. punching pressure.

DOWDING & DOLL LTD

346 KENSINGTON HIGH STREET, LONDON, W.14

Tel: WESTERN 8077 (8 lines) *Telex:* 23182 *Grams:* ACCURATOOL LONDON TELEX

CONTINUOUS Q measurements without resetting



Q METER TYPE CM1.

The internal R.F. signal of the Advance 'Q' meter Type CM1 is stabilized to eliminate re-adjustment of the R.F. level setting, irrespective of changes in the frequency range or mains fluctuations. Scales calibrated in terms of C, Lf^2 and Xf simplify calculations of capacitance, inductance and reactance, while 'Delta C' and 'Delta Q' controls enable comparison measurements to be made with ease. Indeed, the CM1 is the ideal instrument for the batch testing of components and for measurements over long periods where accuracy is required.

- *Wide frequency range (100 Kc/s–100 Mc/s)*
- *Low minimum capacity (10 μμF–600 μμF)*
- *No resetting adjustments necessary during measurements*
- *Constant voltage transformer incorporated ensures good stability*
- *Facilities for Q and C comparison measurements*

Nett price in U.K. £190

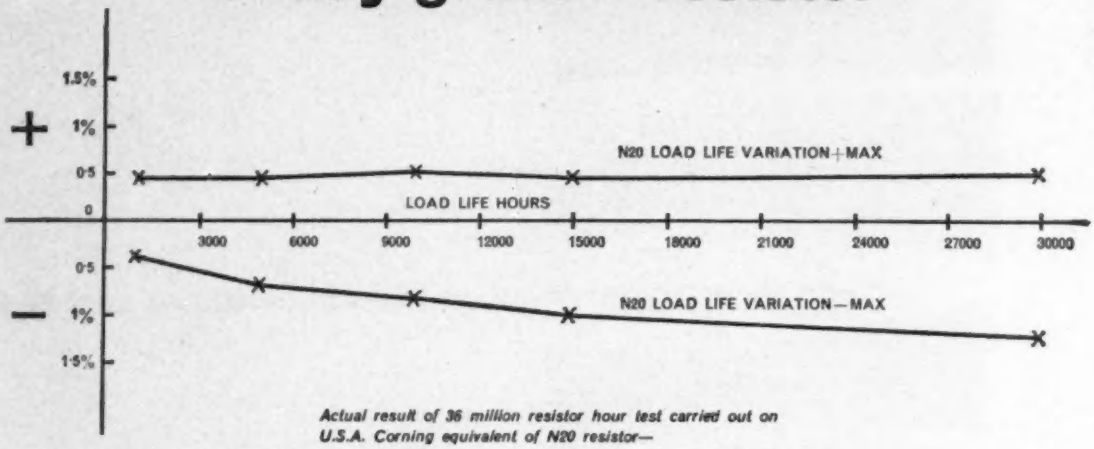
Advance

COMPONENTS LIMITED
INSTRUMENTS DIVISION
Roebuck Road, Hainault, Ilford, Essex
Hainault 4444

SBI/6

EE 40 072 *for further details*

SPECIFY 'ELECTROSIL' for smallest load-life variation of any grade 1 resistor



Actual result of 36 million resistor hour test carried out on U.S.A. Corning equivalent of N20 resistor—

Electrosil metal oxide resistors incorporate certain patented features which result in outstanding stability and reliability, and a typical noise level of 0.015 μv/v. Resistance change under load shown is under conditions varying from light loading to 140% full rated load, on the N20 resistor. Temperature coefficient is less than ±300 p.p.m. per °C.

The improved stability of Electrosil resistors allows more efficient and economical circuit planning, and frequently makes it practical for designers to specify wider purchase tolerances with still further saving of cost.

Low price

N20	5%	5,000	1,000	500	100
100-100K ohms.		5.75	6.25	6.75	7.25

Prices in pence per resistor for quantities per ohmic value.

Style N20 is just one of the 'Electrosil' range of metal oxide resistors.

Availability: Now in quantity production. Many preferred ohmic values are available for immediate delivery.

Purchase Tolerances 1% 2% 5%

Style	Wattage (40°)	Wattage (70°)	DEF 5114	Type* Approval Status	Range	Max. D.C. Volts	Size
N20	1/2	.35	Style RO1-C		100-500K	350	19/32" x 11/64"
N22	3/4	.5			200-500K	350	15/16" x 11/64"
N25	1	.7	Style RO1-B	510-39K	100-1.5M	500	15/16" x 19/64"
N30	2	1.4	Style RO1-A	750-240K	200-2.2M	750	2-1/16" x 19/64"

**All styles now conform to the requirements of DEF 5114 (humidity H1) throughout their resistance ranges and are now undergoing type approval testing.*

Electrosil METAL OXIDE FILM RESISTORS

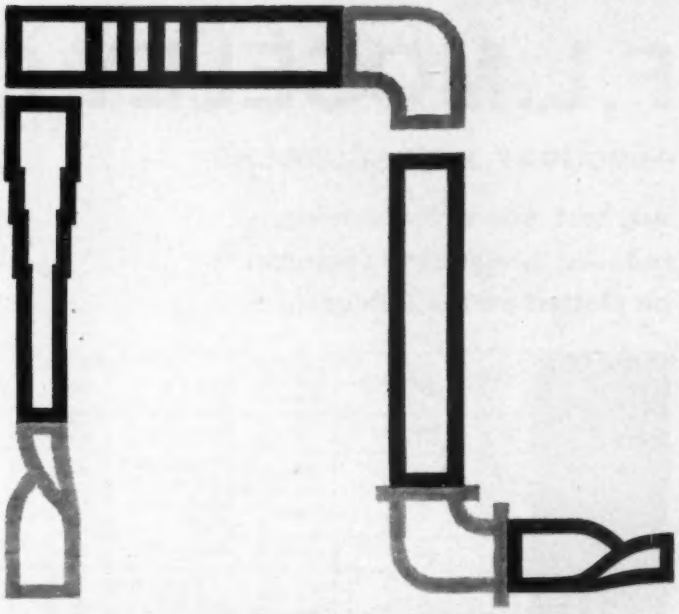
Regd. Trade Mark

Electrosil Limited, Coinbrook By-Pass, Coinbrook, Slough, Bucks.

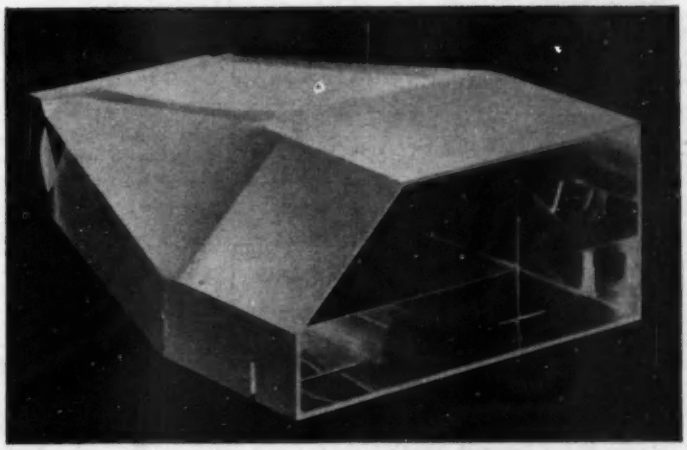
Controlled by James A. Jobling & Co. Ltd. and the Corning Glass Works of Canada

Telephone: Coinbrook 2196 Telegrams: Esil

EE 40 073 *for further details*



Decca Electroforms for microwave and allied applications



Decca Radar Limited operate a full-scale production unit for the design and manufacture of copper electroforms. The process enables complex components to be produced to a high degree of accuracy and at a very economical cost.

Decca Electroforms have these advantages:—

- *Ease of production for large or small batches.*
- *Excellent mechanical and electrical properties.*
- *High electrical and mechanical repetitive accuracy.*
- *Small space requirement. Production accuracy results in waveguide components having path lengths approximately one third those of bent tube or fabricated construction, for equivalent impedance matches.*
- *Economical production of prototypes from sketches.*

DECCA RADAR

Send your enquiries to:—
DECCA RADAR LIMITED
Special Products Division

Albert Embankment London SE1 · RELiance 8111

DR175

EE 40 074 *for further details*

F. L. MOSELEY CO.

HEWLETT-PACKARD SUBSIDIARY

AUTOGRAF X-Y RECORDERS

Any test data which can be reduced to electrical form can be plotted on the Autograf.

Model 2D

X-Y-Recorder «Autograf»	Model	Paper size	Pen speed (full scale deflection)	Input Voltage Ranges DC	Input Voltage Ranges AC	Time base intervals	Other characteristics		Price
	1	8½" × 11"	1 sec	5 mV – 100 V	with A1 converter		Paper on drum		£ 430
	2 D	11" × 17"	20"/sec	7.5 mV – 150 V X-Axis	1.5 V – 150 V	7.5 – 750 sec	Vacuum hold-down Roll chart optional	Accuracy 0,2 % of full scale	£ 950
	2 S		1 sec	5 mV – 100 V Y-Axis					£ 800
	3 S	8½" × 11"	0.5 sec	5 mV – 500 V		5 – 500 sec			£ 560
	4 B	11" × 17"	1 sec	7.5 mV – 150 V X-Axis	with A1 converter	7.5 – 750 sec	Rack mount		£ 1440
	4 S			5 mV – 100 V Y-Axis			Rack mount		£ 800
	5 S	8½" × 11"	0.5 sec	5 mV – 500 V		5 – 500 sec	Rack mount		£ 630
	6 S	10" × 10"	< 1 sec	5 mV – 100 V			Rack mount Paper on rolls		£ 1000

Strip Chart Recorder	Model	Paper width	Pen speed (full scale deflection)	Input Voltage Range DC	Input resistance	Chart speeds	Accuracy		Price
	60 A	10" ROLL	.25 sec	5 mV – 100 V	200 000 Ω/V max. 2 MΩ	6 speeds 2" – 60"/min	0,2 %		£ 874

Logarithmic Converter	Model	Dynamic Range	Stability	Accuracy	Response speed	Input Voltage Ranges DC	Input Voltage Ranges AC		Price
	60 B	60 db	± 0.5 db	± 0.5 db	20 db/sec	3.16 mV – 316 V	1 mV – 100 V 20 cps – 20 KC		£ 240

Accessories available:

Model 30A Card Translator
Model 40A Keyboard
Type F1 Curve Follower Adaptor
Type A-1 AC to DC Converter
Type D-1 Character Printer

The Autograf X-Y Recorder is a complete self-contained instrument which will record directly in Cartesian coordinate form many mechanical and physical, as well as electrical phenomena.
As a curve follower, it will control many industrial and manufacturing processes. Used in laboratories and industrial plants throughout the world.

Prices delivered U.K. exclusive of duty where payable. Continuous progress in design may affect the above specifications which are therefore subject to change without notice. For information, technical sales and engineering help, or a demonstration please write or call

Hewlett-Packard S.A.

Geneva (Switzerland) Rue du Vieux-Billard 1, Tel. (022) 26 43 36

Exclusive Distributor for United Kingdom:

LIVINGSTON LABORATORIES LTD.
31, CAMDEN ROAD, LONDON, N.W.1

Telephone: GULliver 8501 (10 lines) HPSA - 9 - 412

leads the way

EE 40 075 *for further details*

CONTROLLED
POWER

Generally known for sternly withstanding fierce charges are G.E.C.'s silicon controlled rectifiers, ideal for power control and power switching applications at voltages up to 400 V and currents up to 70 A.

Write for details to G.E.C. **SEMICONDUCTORS**

THE GENERAL ELECTRIC COMPANY LIMITED · SEMICONDUCTOR DIVISION · SCHOOL STREET
HAZEL GROVE · STOCKPORT · CHESHIRE · OR, IN THE LONDON AREA, RING: TEMPLE BAR 8000 EXT. 10

EE 40 076 *for further details*

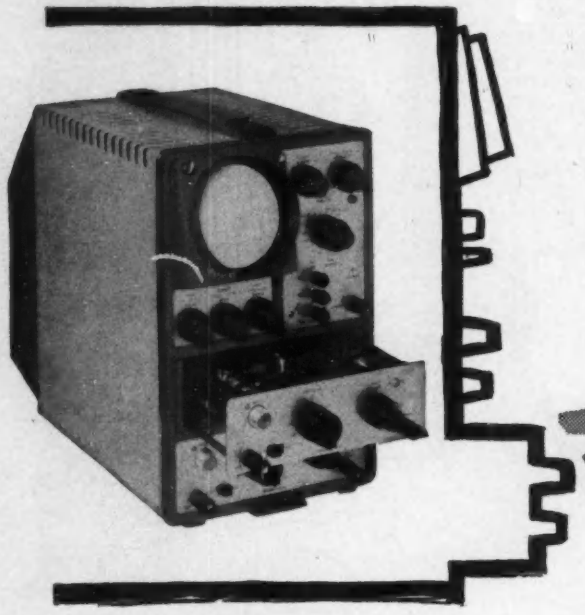
D 33 is more than a new oscilloscope... it is a new oscilloscope system.

D 33 is built to the familiar high standards of all Serviscope equipment. A special feature is the 3½" double-beam PDA tube of advanced design, operating at 3.5 KV to give an exceptionally clear trace.

PDA TUBE

HIGH GAIN

INTERCHANGEABLE AMPLIFIERS



a

GENERAL PURPOSE AMPLIFIER
dual range
1. D.C.—6 Mc/s at 100 mV/cm.
2. D.C.—200 Kc/s at 10 mV/cm.

b

DIFFERENTIAL AMPLIFIER
Maximum sensitivity 1 mV/cm D.C.—200 Kc/s. High common-mode rejection.

c

ULTRA HIGH GAIN AMPLIFIER
Maximum sensitivity 100 uV/cm, 5 c/s to 150 Kc/s.

Amplifiers are under development for strain gauge and transducer work and for higher bandwidths (10 Mc/s).

Interchangeable plug-in Y amplifiers allow one instrument to be adapted to a wide range of applications, and still to remain compact, portable . . . and inexpensive. All connections are made internally as the unit slides home. All or any of the basic range of amplifiers can be supplied, or special units can be built to requirements.

D 33
double beam
SERVISCOPE*
with plug-in
amplifiers

WIDE RANGE CALIBRATED TIME BASE has 18 pre-set sweep speeds from 1 usec/cm to ½ sec/cm (or slower if necessary) and a variable control covering intermediate speeds.

VERSATILE TRIGGERING CIRCUIT allows two modes of triggering:—
1. Automatic synchronisation. The time base locks automatically to any frequency between a few cycles and 1 Mc/s at any input level.
2. Selective triggering. Enables the time base to be triggered from any selected point on the input waveform.

X EXPANSION CONTROL x10 DIAMETERS

NEW D.C. COUPLED FLYBACK BLANKING ensures uniform trace brightness at slow sweep speeds and complete flyback suppression.

ILLUMINATED GRATICULE facilitates accurate measurements.

TELEQUIPMENT

* '*Serviscope*' *is the registered trade mark of* Telequipment Limited,

313 Chase Road, Southgate, London, N.14. Fox Lane 1166

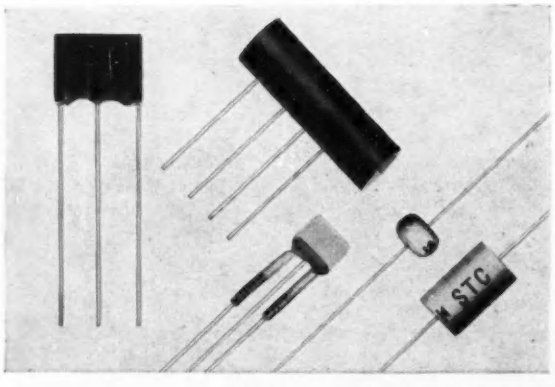
STC COMPONENTS REVIEW

MINIATURE SELENIUM RECTIFIERS

The existing range of Miniature Selenium Rectifier Assemblies manufactured by the STC Rectifier Division has been extended. The previous range of miniature rectifiers included the "M" type and the "Q" and "MQ" Unistor.

Type	Description	Remarks
M	Single plate in aluminium case.	Half-wave device fitted to axial leads (Plate types 1 or 3).
T	One plate or two plates in aluminium case.	Half-wave device fitted to axial leads (Plate types 1, 3, 6, 8 or 9).
Q	Up to five plates in series in moulded nylon case.	
MQ	As for Q but hermetically sealed and tropicalised.	
P	Up to five plates in moulded rectangular plastic case shaped for automatic insertion.	Available in half-wave, doubler, push, pull or bridge configuration, with multiple leads (Plate types 1, 3, 6, 8 or 9).
R	Is a skeleton form of P for use in restricted space.	
L	Cylindrical case in two sizes for up to ten or up to twenty plates.	

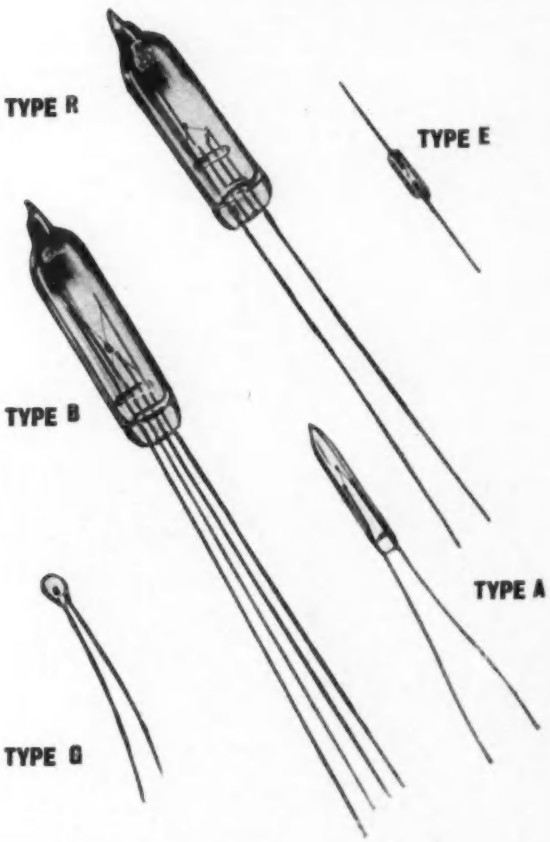
These SenTerCel Selenium Rectifiers are designed for use in electronic circuits calling for a diode of good reverse/forward resistance ratio and closely controlled characteristics. When used in place of thermionic valves SenTerCel Miniature Rectifiers virtually eliminate problems of heat dissipation and a.c. hum, and save the cost of provision of heater power, valve bases and associated wiring.



Full details are contained in Advance Information booklets "Miniature Selenium Rectifiers" and "Applications of Miniature Selenium Rectifiers", *available from STC Rectifier Division, Edinburgh Way, Harlow, Essex.*

EE 40 1 *for further details*

THERMISTORS IN ELECTRONICS



The use of thermistors in electronic circuits is now well established, especially for the control of output power and the measurement of the power in complex waveforms. STC offer a very wide range of thermistors designed specifically for these and many allied applications. For example, the type R thermistor was designed for circuits operating at very low power levels. A power input of only 3 mW will reduce the resistance of this device to less than 1/20 of its value when cold.

★ SENSITIVE ★ SMALL ★ ROBUST ★ RELIABLE

Consult leaflet MK/140 which contains summary information on all types in the standard range or contact the Transistor Division for guidance on your particular problem—STC Transistor Division, Footscray, Sidcup, Kent.

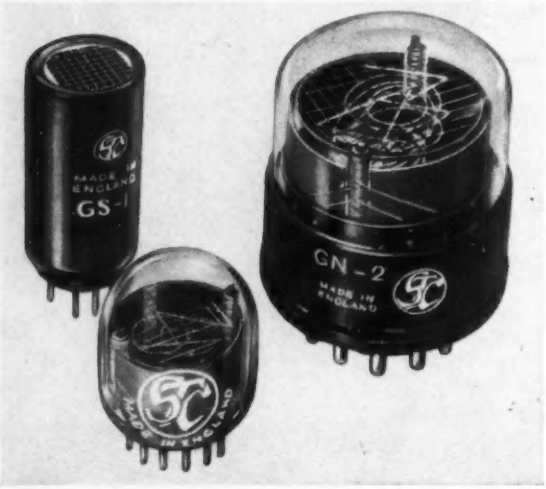
EE 40 2 *for further details*

CONTINUED OVER

COLD CATHODE INDICATOR TUBES

for displaying numbers and symbols

These tubes in the STC range are intended for end-viewing and the symbol tube GS-1 is matched for seated and operating voltages with the larger number tube GN-2. The GN-2 tube directly replaces the earlier type GN-1 in all d.c. (or rectified unsmoothed a.c.) circuits and is of improved design and construction. Type GN-3 is directly equivalent to U.S.A. type 6884A.



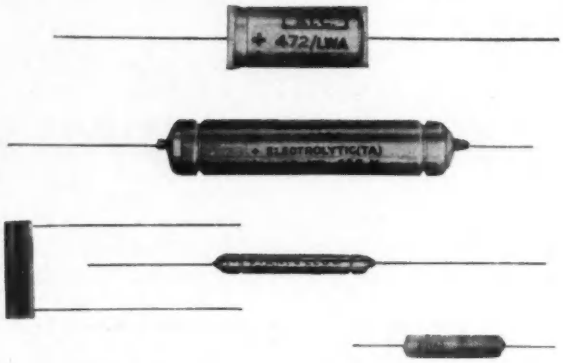
ABRIDGED DATA

TYPE	GN-2	GN-3	GS-1
DISPLAY	0-9	0-9	+ or −
DIAMETER (mm)	45	28	22
BASE	B12A	B13B	B9A/D
MINIMUM SUPPLY Voltage (V)	200	170	200
NOMINAL CATHODE Current (mA)	3·5	2·0	1·5

Write for Data Sheets to STC Valve Division, Brixham Road, Paignton, Devon or London Sales Office, Footscray, Kent.

EE 40 3 *for further details*

STANTELUM CAPACITORS



STC hermetically sealed tantalum capacitors, marketed under the trade name STANTELUM, are manufactured in four main groups:

HIGH TEMPERATURE FOIL TYPE

This is a range of tantalum capacitors for operation up to 125°C and the devices are manufactured to withstand vibration conditions far in excess of those specified in RCS 134B

Temperature range	−40 to +125°C
Voltage range	6 to 100V d.c.
Capacitance range	Polarized types 0·4 to 200 μF Non-polarized types 0·2 to 100 μF

STANDARD FOIL TYPE

First in the Stantelum range, this type has been incorporated into numerous communications and industrial equipments since its introduction in 1954. The range is Type Approved to RCS 134B

Temperature range	−40 to +85°C
Voltage range	6 to 150V d.c. (at 50°C)
Capacitance range	Polarized types 0·3 to 200 μF Non-polarized types 0·15 to 100 μF

MINIATURE FOIL TYPE

Miniature Stantelum capacitors are a further development of the standard foil range. They have a space factor proportionate to their rated working voltage resulting in components of the smallest physical size. Available with axial or radial terminal wires.

Temperature range	−25 to +85°C
Voltage range	3 to 25V d.c.
Capacitance range	1·5 to 16 μF

Polarized types

SOLID TANTALUM

Solid tantalum capacitors give up to three times capacitance, for a given rated voltage, as compared with the foil type capacitors. The range has been designed in line with MIL Specification C-26655-2

Temperature range	−55 to +125°C (With voltage derating. Refer to technical data sheets for details).
Voltage range	6 to 35V d.c.
Capacitance range	1 to 330 μF

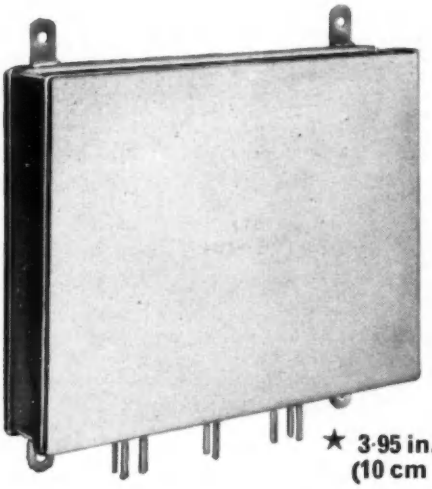
Polarized types. Sintered slug and solid electrolyte construction

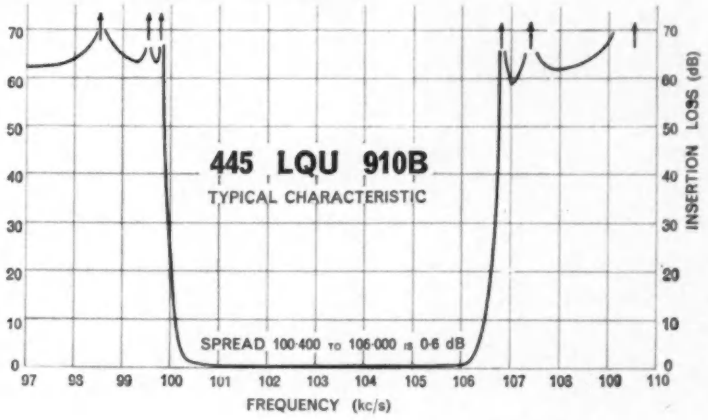
For full details of these capacitors, ask for Technical Data Sheets from STC Capacitor Division, Brixham Road, Paignton, Devon.

EE 40 4 *for further details*

PACKAGED SELECTIVITY WITH NEW MINIATURE 100 kc/s SINGLE SIDE-BAND CRYSTAL FILTER

for independent S.S.B. communications equipment





★ **3·95 in. x 3·5 in. x 1·02 in. (10 cm x 8,9 cm x 2,7 cm)**

★ **Small insertion loss**

★ **Good carrier suppression**

★ **Minimum side-band ripple**

Filters also available for lower side-band

Write for Data Sheets to STC Quartz Crystal Division, Temple Fields, Harlow, Essex.

EE 40 5 *for further details*

STC HIGH 'Q' STANFERITE POT CORES FOR FILTER COILS AND OTHER APPLICATIONS

The range of STANFERITE air-gapped pot cores is provided with a minimum setting inductance adjustment of −3% or −5% to +5%. This is achieved by rotating one half of the pot core relative to the other, and is produced by an asymmetric airgap resulting in a flux distortion. This is used primarily to compensate for the spread in capacitor and other component tolerances associated with the inductor, without recourse to mechanical adjustment of the airgap, and in so doing enables a standard number of turns to be used.

Technical Data Sheets available from STC Magnetic Materials Dept., Edinburgh Way, Harlow, Essex.

EE 40 6 *for further details*

TYPE	DIMENSIONS (Approx.)		INDUCTANCE RANGE (Nominal)	FREQUENCY RANGE (Nominal)	'Q' RANGE (Nominal)	EFFECTIVE PERMEABILITY		HYSTERESIS FACTOR MAXIMUM	
	Diameter in.	Height in.				With gap	Without gap	With gap	Without gap
PC1	0·25	0·16	30μH to 9mH	—	—	—	> 400	—	3 000
PC1A	0·25	0·1	30μH to 6mH	—	—	—	> 400	—	3 500
PC2	0·5	0·32	30μH to 100mH	500c/s to 3Mc/s	30 to 300	25, 50, 100, 150	> 600	4·6 to 67	550
PC3	0·75	0·57	30μH to 1H	200c/s to 3Mc/s	30 to 300	25, 50, 100, 150	> 900	4·1 to 60	890
PC4	1·0	0·68	30μH to 5H	100c/s to 3Mc/s	30 to 600	25, 50, 100, 150	> 1 000	1·6 to 21·5	370
PC5	1·5	1·0	30μH to 15H	50c/s to 2Mc/s	30 to 1 000	25, 50, 100, 150	> 1 200	0·97 to 15	340

Standard Telephones and Cables Limited

COMPONENTS GROUP · FOOTSCRAY · SIDCUP · KENT

EE 40 080 for further details

No. 4 IN THE SERIES

Technical Information for the Transistor Circuit Designer

Thermal Runaway

The maximum temperature at which a circuit will operate is not always determined by the maximum power rating of the transistor but by its thermal stability in the circuit. The thermal stability of the circuit depends partly on the stability factor which was discussed in an earlier note in this series.

What, then, does the circuit designer want to know?

(1) Given the maximum ambient temperature and power dissipation, he will want to know the stability factor.

(2) Given a maximum ambient temperature, he will want to know the power he can dissipate for a given stability factor.

(3) Given the dissipation and stability factor, he will want to know the maximum ambient temperature for safe operation.

For case (1) when the junction temperature (i.e. the ambient temperature and dissipation) and the value of I_{CBO} at that temperature are known, the expression for the stability factor is relatively simple:—

$$S < \frac{1}{V\theta K I_{CBO}} \quad \text{.....(1)}$$

where S is the stability factor (defined in No. 3 of this series)

V is the voltage

θ is the thermal resistance of the transistor (in a heat sink if used)

K is a constant $= \dfrac{\log_e 2}{T_D}$

where T_D is the temperature change to double or halve I_{CBO}. (K is typically of the order of 0.07 to 0.09 for germanium)

I_{CBO} is the value of the leakage current at the *appropriate junction temperature* T_j, and $T_j = T_{amb} + P_D\theta$

where P_D is the total device dissipation.

For case (2) the maximum allowable power dissipation is:

$$P_D < \frac{1}{\theta}\left(T_R - T_{amb} + \frac{2{\cdot}3}{K}\log_{10}\frac{1}{KSV_C\theta I_{CBO}}\right) \quad \text{.....(2)}$$

For case (3) the maximum permissible ambient temperature is:

$$T_{amb} < \left(T_R - P_D\theta + \frac{2{\cdot}3}{K}\log_{10}\frac{1}{KSV_C\theta I_{CBO}}\right) \quad \text{.....(3)}$$

where T_R is some reference temperature (usually 25°C) at which the value of I_{CBO} used in (2) and (3) above is known.

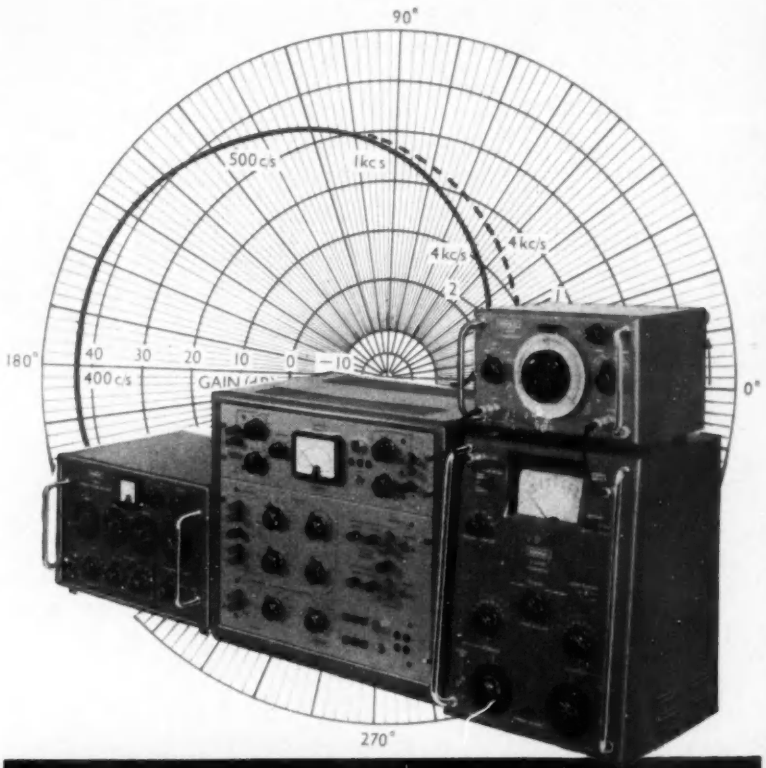
It is clear that the thermal stability can be improved by having a lower value of supply voltage and a more effective heat sink. In estimating the thermal stability, one should always consider the case of those transistors which have the highest values of I_{CBO}.

Of course, the above is subject to individual temperature, power and voltage ratings, given in the data sheet, not being exceeded.

STC TRANSISTOR TYPE	TK 20C	TK 23C	TK 25C	TK 28C	TK 30C	TK 31C	TK 40C	TK 41C	TK 42C
Max. I_{CBO} at 25°C (μA)	5	5	5	5†	5	5	5	6	6
Max. I_{CBO} at 60°C (μA)	30†	50†	30†	30†	30†	30†	50†	50†	50†
K	0·05 *	0·087	0·05 *	0·05 *	0·05 *	0·05 *	0·087	0·087	0·087

*Note that the value of K for a typical transistor is higher than that for a limit transistor and is about 0·077. †95% limit.

Standard Telephones and Cables Limited
TRANSISTOR DIVISION: FOOTSCRAY · SIDCUP · KENT
61/4MK



MUIRHEAD Transfer Function Analyser

The MUIRHEAD Transfer Function Analyser provides a highly versatile and convenient method of testing the frequency response of d.c. and carrier-type servo systems. Direct readings of phase angle and relative amplitude between any two points of a system can be achieved with ease and a high degree of accuracy. Absolute amplitude may also be measured. The equipment operates over a frequency range 0.5 c/s to 10 kc/s.
Ask for Publication 109—it describes the equipment in detail.

MUIRHEAD

PRECISION ELECTRICAL INSTRUMENTS

MUIRHEAD & CO. LIMITED, Beckenham, Kent, England.
Telephone: Beckenham 4888
MUIRHEAD INSTRUMENTS LIMITED, Stratford, Ontario, Canada.
Telephone: 271-3880
MUIRHEAD INSTRUMENTS INC., 441 Lexington Avenue, New York 17, N.Y., U.S.A.
Telephone: Murray Hill 2-8131

511

Synchros?

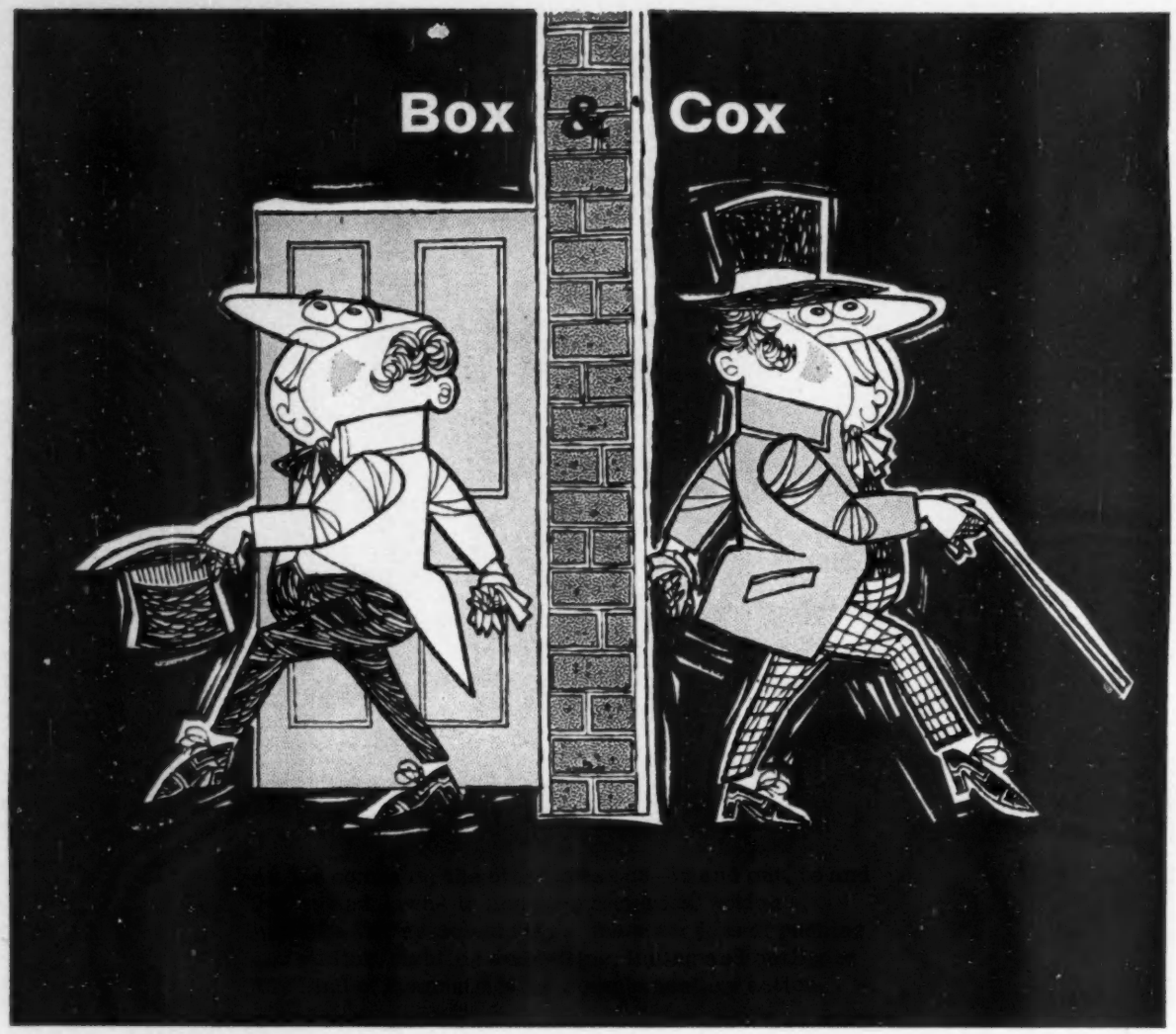
Servomotors?

MUIRHEAD have a range of more than 100 types in sizes from 08 to 23 manufactured to United States, British and N.A.T.O. Military Standards.

MUIRHEAD

PRECISION ELECTRICAL INSTRUMENTS

520

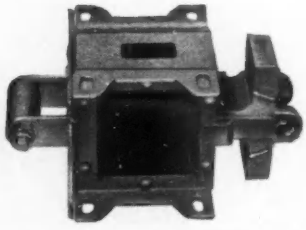


Varley solenoids

REGD. TRADE MARK

Type D2

Laminated construction. All round fixing arrangements. Thrust types fitted with straight through guide bars to which can be fitted either rollers or thrust blocks.
Performance: 4 to 7 lbs. through ¾" stroke (depending on rating).



For full details of Varley Solenoids, write for Illustrated Catalogue L.1.

OLIVER PELL CONTROL LTD

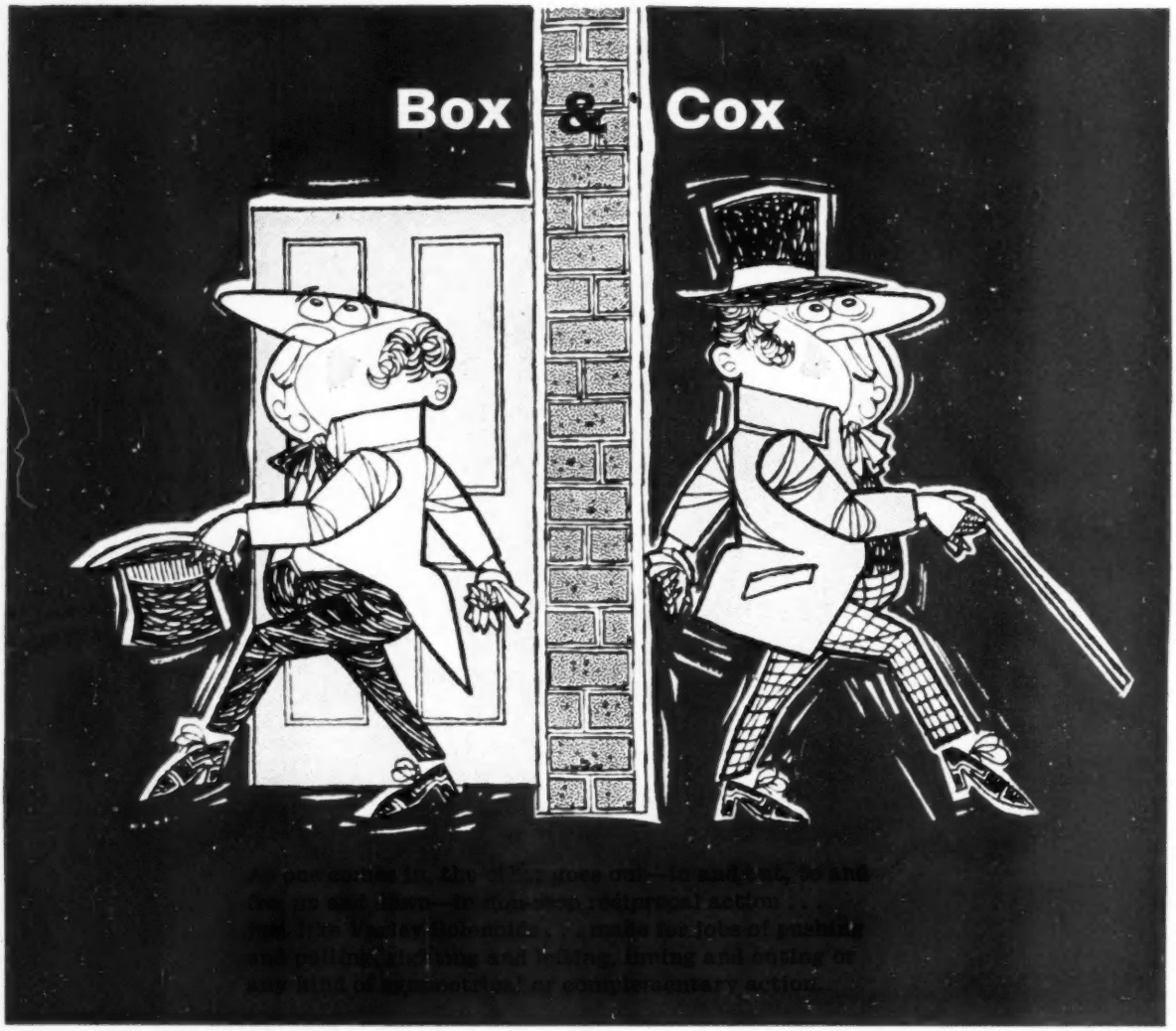
CAMBRIDGE ROW, BURRAGE ROAD, WOOLWICH, S.E.18

Telephone: Woolwich 1422 (five lines) Telegrams: Olipel, London, S.E.18

TA 5498

MULLARD SEMICONDUCTORS—PRECISION MADE BY THE MILLION

fifty types of
switching semiconductors
for 0-100kc/s p.r.f.

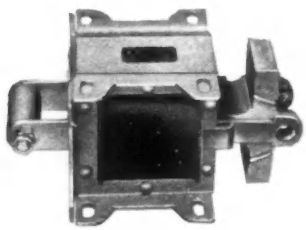


Varley solenoids

REGD. TRADE MARK

Type D2

Laminated construction. All round fixing arrangements. Thrust types fitted with straight through guide bars to which can be fitted either rollers or thrust blocks.
Performance: 4 to 7 lbs. through $\frac{3}{4}$" stroke (depending on rating).



For full details of Varley Solenoids, write for Illustrated Catalogue L.1.

OLIVER PELL CONTROL LTD

CAMBRIDGE ROW, BURRAGE ROAD, WOOLWICH, S.E.18

Telephone: Woolwich 1422 (five lines) Telegrams: Olipel, London S.E.18

TA 5498

MULLARD SEMICONDUCTORS—PRECISION MADE BY THE MILLION

fifty types of
switching semiconductors
for 0-100kc/s p.r.f.

EE 40 084 *for further details*

ANGLO-AMERICAN LINK-UP

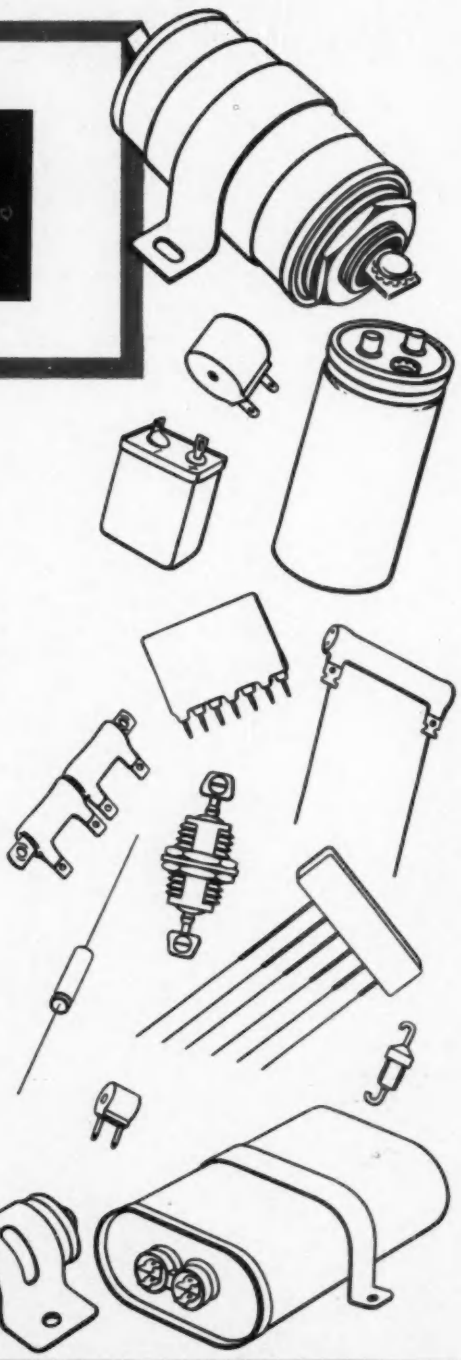
Interchange of 'know-how' of great value to Industry

TCC

SPRAGUE

THE MARK OF RELIABILITY

GREAT BRITAIN — AMERICA



An agreement of far-reaching importance to all engaged in Radio and Television and in the Electronics and Electrical industries is operating between The Telegraph Condenser Company, Britain's oldest—and Europe's largest—manufacturers of condensers, and the Sprague Electric Company, by far the largest manufacturers of capacitors, electrical components, etc. in America.

Under this arrangement the two organisations share their vast research and manufacturing experience. Such mutual collaboration cannot fail to be of the utmost value to electronic and electrical engineers.

T.C.C. are proud to be allied with this development, and invite you to make the fullest use of the service available.

EXCLUSIVE DISTRIBUTORS FOR SPRAGUE PRODUCTS IN THE UNITED KINGDOM

THE TELEGRAPH CONDENSER CO. LTD.

NORTH ACTON · LONDON · W.3

TEL: ACORN 0061

MULLARD SEMICONDUCTORS–PRECISION MADE BY THE MILLION

over twenty-five
switching semiconductors
for 100kc/s–20Mc/s p.r.f.

EE 40 084 *for further details*

ANGLO-AMERICAN LINK-UP

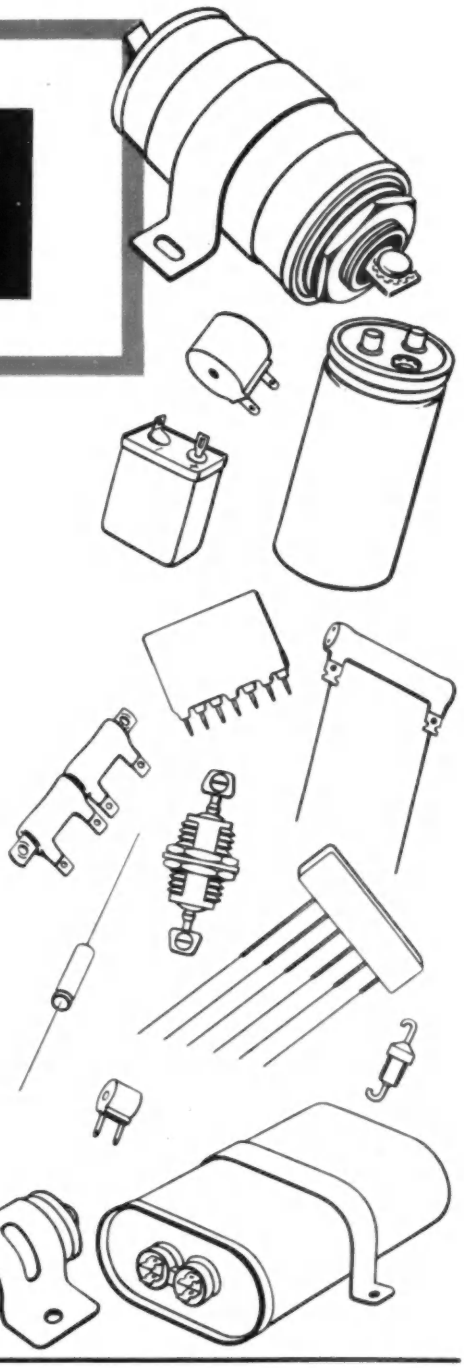
Interchange of 'know-how' of great value to Industry

TCC

SPRAGUE®

THE MARK OF RELIABILITY

GREAT BRITAIN — AMERICA



An agreement of far-reaching importance to all engaged in Radio and Television and in the Electronics and Electrical industries is operating between The Telegraph Condenser Company, Britain's oldest—and Europe's largest—manufacturers of condensers, and the Sprague Electric Company, by far the largest manufacturers of capacitors, electrical components, etc. in America.

Under this arrangement the two organisations share their vast research and manufacturing experience. Such mutual collaboration cannot fail to be of the utmost value to electronic and electrical engineers.

T.C.C. are proud to be allied with this development, and invite you to make the fullest use of the service available.

EXCLUSIVE DISTRIBUTORS FOR SPRAGUE PRODUCTS IN THE UNITED KINGDOM

THE TELEGRAPH CONDENSER CO. LTD.

NORTH ACTON · LONDON · W.3

TEL: ACORN 0061

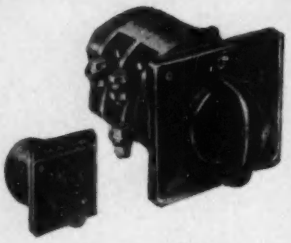
MULLARD SEMICONDUCTORS—PRECISION MADE BY THE MILLION

over twenty-five switching semiconductors for 100kc/s–20Mc/s p.r.f.

EE 40 086 *for further details*

All your switching requirements are met by the BLUE LINE range

The unique construction of Chilton Blue Line Rotary Switches enables rapid assembly of custom-built switching arrangements for any duty, and permits complete standardisation of switching in customers' products. Up to 200% increase in multi-circuit control capability from a single switch is possible, with economy of space and great reduction in component costs.



Six sizes with load ratings of 10, 20, 40, 60, 100 and 200 amperes. Higher ratings are available for certain applications.

Angular movements of 10°, 15°, 20°, 30°, 36°, 45° and 90° are available giving from two to thirty-six positions.

Ganging permits operation of up to 96 contacts from one operating handle.

Switches of different ratings may be joined together as a single assembly

Interlocks between switches, push pull devices, push or pull to turn interlocks etc. available.

Rotary solenoid drives enable switches to replace complete systems of relays and contactors.

Write for literature on the world's most versatile switches and let Chilton advise you on your current switching problems.

CHILTON

BLUE LINE ROTARY SWITCHES

CHILTON ELECTRIC PRODUCTS LIMITED

Hungerford, Berks. Telephone: Hungerford 237/8

London Office: 19, Old Queen Street, London SW1. Tel: TRAfalgar 2239

AP/105

3 into 1 will go —

and produce a low-priced

BE Digital Recorder (BIE2814)

This portable Digital Recorder comprises the well-proved B E 50-channel Scanning Switch, Digital Voltmeter and the H P Strip Printer.

The unit may be operated at a scanning rate of 1 or 3 channels per second in any one of 3 modes: continuous scanning of all selected channels: single scan of all selected channels: continuous sampling of 1 selected channel. Channels may be selected for scanning in groups of 10. The Voltmeter incorporates 3 automatically selected ranges from 0 to ± 999·9 volts with an accuracy of 0·05% of full scale on any range.

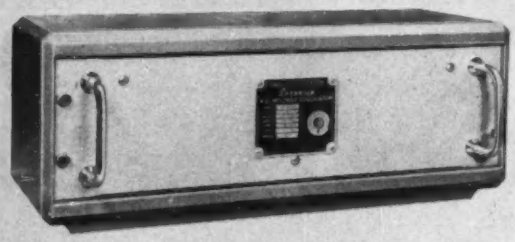
Print-out comprises channel identification, voltage magnitude, polarity and decimal point.

For further information please write to:

BLACKBURN ELECTRONICS LIMITED
BROUGH YORKSHIRE **TELEPHONE BROUGH 121**
Member Company of Hawker Siddeley Aviation

EE 40 088 *for further details*

A. C. POWER SUPPLIES



NEW

TRANSISTORISED VOLTAGE REGULATORS

LT-T 200-R	200VA	£47.10.0
LT-T1000-R	1000VA	Available soon
LT-T3000-R	3000VA	

- Smaller Size
- Lower Price
- More Robust

ELECTRONIC VOLTAGE REGULATORS

LT 150-R 150VA	£47.10.0
LT 500-R 500VA	£77.10.0
LT 1000-R 1000VA	£97.10.0
LT 3000-R 3000VA	£180. 0.0
LT 5000-R 5000VA	£322. 0.0
LT10000-R 10000VA	£470. 0.0
LT15000-R 15000VA	£770. 0.0

- ±0·1% regulation against input changes
- Response Time 0·1 second
- Less than 3% Distortion

CONSTANT VOLTAGE TRANSFORMERS

LT-MVR- 120	120VA	£11.10.0
LT-MVR- 300	300VA	£19. 5.0
LT-MVR-1000	1000VA	£42. 0.0

- ±0·5% regulation against input changes
- Fast Response
- Small Size
- Automatic Overload Protection

JLT
POWER SUPPLY DIVISION

J. LANGHAM THOMPSON LTD.

POWER SUPPLY DIVISION

BUSHEY HEATH · HERTFORDSHIRE · ENGLAND

Telephone: Bushey Heath 2411 (6 lines) Grams & Cables: "Tommy Watford"

D. C. TRANSISTOR POWER SUPPLIES

Exceptional regulation, low ripple and fast response characterise the JLT range of D.C. power supplies, which make full use of the latest "double regulator" techniques. Intermediate voltages and alternative power levels can be provided to order. Recommended for a wide variety of built-in applications or for use as bench supplies.

- **0·005% Regulation**
- **Small size**
- **Low Cost**
- **Transient-free output**
- **Automatic Overload Protection**
- **Unaffected by wide input voltage changes**

	Model	Output Volts	Output Current	Regulation	Input Volts	Equivalent Resistance	Impedance	Ripple (RMS)	Price	Dimensions H	W	D
30 VA	LTE4/12·5–1·5	4–12½	1·5A	±0·005%	185–260	0·01Ω	0·01Ω	0·001V	£45	4½″	4″	15½″
	5–2	5±½V	2A	±0·005%	185–260	0·01Ω	0·01Ω	0·001V	£45	4½″	4″	15½″
	6–2	6±½V	2A	±0·005%	185–260	0·01Ω	0·01Ω	0·001V	£45	4½″	4″	15½″
	10–2	10±½V	2A	±0·005%	185–260	0·01Ω	0·01Ω	0·001V	£45	4½″	4″	15½″
	12–2	12±½V	2A	±0·005%	185–260	0·01Ω	0·01Ω	0·001V	£45			
	15–2	15±½V	2A	±0·005%	185–260	0·01Ω	0·01Ω	0·001V	£45			
	18–1·5	18±½V	1·5A	±0·005%	185–260	0·01Ω	0·01Ω	0·001V	£45			
	20–1·5	20±½V	1·5A	±0·005%	185–260	0·01Ω	0·01Ω	0·001V	£45			
	24–1	24±½V	1A	±0·005%	185–260	0·01Ω	0·01Ω	0·001V	£40			
	28–1	28±½V	1A	±0·005%	185–260	0·01Ω	0·01Ω	0·001V	£40			
	30–1	30±½V	1A	±0·005%	185–260	0·01Ω	0·01Ω	0·001V	£40	4½″	4″	15½″
	50–0·5	50±½V	0·5A	±0·005%	185–260	0·01Ω	0·01Ω	0·001V	£40	4½″	4″	15½″
	60–0·5	60±½V	0·5A	±0·005%	185–260	0·01Ω	0·01Ω	0·001V	£40	4½″	4″	15½″
20 VA	LTE 5–1·5	5±½V	1·5A	±0·05%	205–250	0·05Ω	0·05Ω	0·002V	£37	3½″	3¼″	8″
	6–1·5	6±½V	1·5A	±0·05%	205–250	0·05Ω	0·05Ω	0·002V	£37	3½″	3¼″	8″
	10–1·5	10±½V	1·5A	±0·05%	205–250	0·05Ω	0·05Ω	0·002V	£37	3½″	3¼″	8″
	12–1·5	12±½V	1·5A	±0·05%	205–250	0·05Ω	0·05Ω	0·002V	£37			
	15–1	15±½V	1A	±0·05%	205–250	0·05Ω	0·05Ω	0·002V	£37			
	18–1	18±½V	1A	±0·05%	205–250	0·05Ω	0·05Ω	0·002V	£37			
	20–1	20±½V	1A	±0·05%	205–250	0·05Ω	0·05Ω	0·002V	£37			
	24–0·5	24±½V	0·5A	±0·05%	205–250	0·05Ω	0·05Ω	0·002V	£32			
	28–0·5	28±½V	0·5A	±0·05%	205–250	0·05Ω	0·05Ω	0·002V	£32			
	30–0·5	30±½V	0·5A	±0·05%	205–250	0·05Ω	0·05Ω	0·002V	£32	3½″	3¼″	8″
60 VA	LTE 5–5	5±½V	5A	±0·01%	190–260	0·01Ω	0·01Ω	0·002V	£60	5⅞″	5″	17·5″
	6–5	6±½V	5A	±0·01%	190–260	0·01Ω	0·01Ω	0·002V	£60	5⅞″	5″	17·5″
	10–5	10±½V	5A	±0·01%	190–260	0·01Ω	0·01Ω	0·002V	£60	5⅞″	5″	17·5″
	12–5	12±½V	5A	±0·01%	190–260	0·01Ω	0·01Ω	0·002V	£60			
	15–4	15±½V	4A	±0·01%	190–260	0·01Ω	0·01Ω	0·002V	£60			
	18–3	18±½V	3A	±0·01%	190–260	0·01Ω	0·01Ω	0·002V	£50			
	20–3	20±½V	3A	±0·01%	190–260	0·01Ω	0·01Ω	0·002V	£50			
	24–2·5	24±½V	2·5A	±0·01%	190–260	0·01Ω	0·01Ω	0·002V	£50			
	28–2	28±½V	2A	±0·01%	190–260	0·01Ω	0·01Ω	0·002V	£45			
	30–2	30±½V	2A	±0·01%	190–260	0·01Ω	0·01Ω	0·002V	£45	5⅞″	5″	17·5″
	50–1	50±½V	1A	±0·01%	190–260	0·01Ω	0·01Ω	0·002V	£45	5⅞″	5″	17·5″
	60–1	60±½V	1A	±0·01%	190–260	0·01Ω	0·01Ω	0·002V	£45	5⅞″	5″	17·5″

CLOSE REGULATION

SMALL SIZE

HIGH POWER

J. LANGHAM THOMPSON LTD.

POWER SUPPLY DIVISION

BUSHEY HEATH · HERTFORDSHIRE · ENGLAND

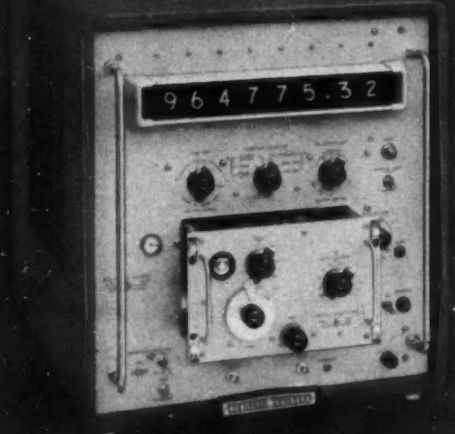
Telephone: Bushey Heath 2411 (6 lines) Grams & Cables: "Tommy Watford"

JLT
POWER SUPPLY DIVISION

EE 40 090 for further details

NOW!

VERSATILE -*hp*- 524C 10 Mc/s COUNTER manufactured in ENGLAND



HEWLETT-PACKARD LTD.
DALLAS ROAD
BEDFORD, ENGLAND

. . . GIVING YOU LOWER COST, FASTER DELIVERY PLUS THESE UNIQUE ENGINEERING FEATURES OF THE -*hp*- 524C:

BRIGHT, IN-LINE NIXIE READOUT ■ VARIED OUTPUT CODE FOR USE WITH NEARLY ALL PRINTERS ■ MAXIMUM VERSATILITY WITH CHOICE OF SEVEN SPECIALIZED PLUG-IN UNITS ■ ■

Now manufactured in Bedford, England, the popular Hewlett-Packard 524C 10-Megacycle Electronic Counter is one of today's most useful precision frequency/time measuring instruments. ⏻ 524C measures frequency from 10 c/s to 10.1 Mc/s, period to 100 kc/s. With convenient plug-in units for the 524C you can measure frequency to 500 Mc/s (with accessories, to 18.0 Gc/s), and time interval from 1 μsec to 100 days. Accuracy is assured by the 5 parts in 100 million per week stability of its time base crystal oscillator. Measurements are automatic, direct reading, require no tedious calculation or interpolation. Long-life, high intensity, in-line Nixie readout reduces reading error. Output codes, including 4 line, 10 line, staircase, mean virtually any digital recorder or data processing device can be operated simply and directly, without additional equipment. ⏻ 524C, £866.

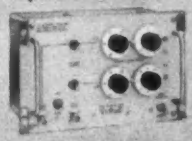
Here's Plug-in versatility available for the -*hp*- 524C 10 Mc/s COUNTER

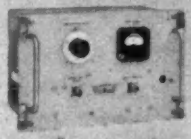
With the 524C, you need only buy the measuring capability initially required—later, should you wish to make new, specialized measurements, you may add other plug-ins. The ϕ 525A Frequency Converter, £90, pictured plugged into the counter on opposite page, extends the frequency measuring capability of the counter to 100 Mc/s.

ϕ 525C Frequency Converter, £153, extends frequency measurements from 100 to 500 Mc/s.

ϕ 525B Frequency Converter, £108, frequency measurements from 100 to 220 Mc/s.

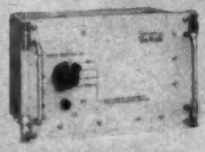
ϕ 526B Time Interval Unit, £72, for time interval measurement 1 μsec to 10^9 sec.

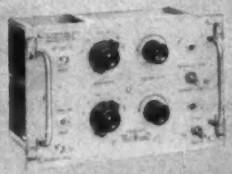




ϕ 526A Video Amplifier, £72, increases counter sensitivity to 10 mv.

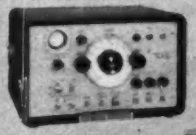
ϕ 526C Period Multiplier, £81, allows measurement to 100 kc/s of 100, 1,000, 10,000 period average.





ϕ 526D Phase Unit, £271, reads phase difference with 0.1 μsec resolution from 1c/s to 20 kc/s.

With the ϕ 540B Transfer Oscillator, £340, and the ϕ P532A Harmonic Mixer, £100, you can extend the 524C frequency measurement range all the way to 18 Gc/s.



The DY-5796 Transfer Oscillator Synchronizer, £274, manufactured by Dymec division of Hewlett-Packard, used with ϕ 540B Transfer Oscillator and the ϕ 524C Counter, permits high-accuracy automatic frequency measurements, even on varying signals, all the way to 12.4 Gc/s. The DY-5796 provides phase locking of the transfer oscillator to the signal frequency, thus giving accuracy equal to that of the counter time base.

Data subject to change without notice. Prices delivered in U.K.

HEWLETT PACKARD

opens manufacturing facility in ENGLAND

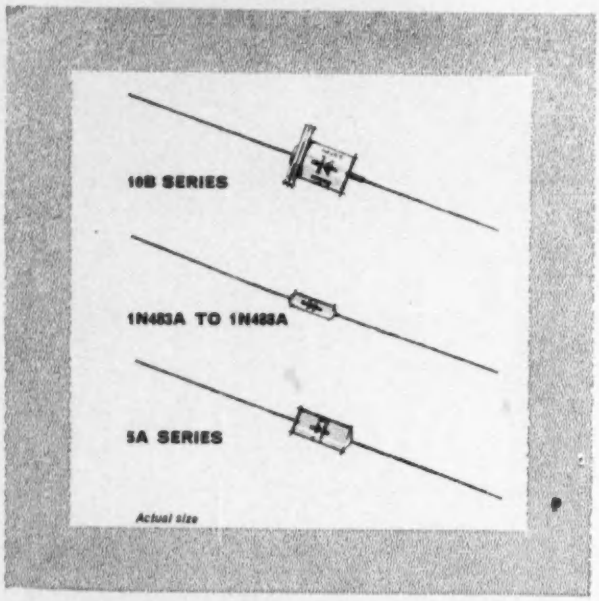
Hewlett-Packard, leading designer and manufacturer of precision electronic instruments, has opened a plant in Bedford, England. This facility is being operated by a new subsidiary, Hewlett-Packard, Ltd.

Initial emphasis at the plant will be on manufacturing, but new products will be developed in the near future. Not only will European instrument users benefit from faster deliveries and often lower prices, but also the Hewlett-Packard Company will be able to maintain even closer contact with electronics research activities throughout the world.

For further information on ϕ 524C electronic counters and accessories, call your ϕ representative, Livingston Laboratories, Ltd. From Livingston Laboratories you can also obtain full information on the more than 400 other precision instruments manufactured by Hewlett-Packard.

LIVINGSTON LABORATORIES, LTD.
31 CAMDEN ROAD, LONDON, N.W. 1
ENGLAND · TEL.: GULLIVER 8501

EE 40 092 *for further details*



DIFFUSED JUNCTION SILICON DIODES

10B SERIES

These four new hermetically sealed rectifiers feature extremely low reverse leakage (500μA at rated P.I.V. at 150°C). Units will give up to 1.8 amps on a heat sink or 1.3 amps without heat sinks in air. Operating temperature range —65°C to +175°C. P.I.V. range from 100 to 600 volts.

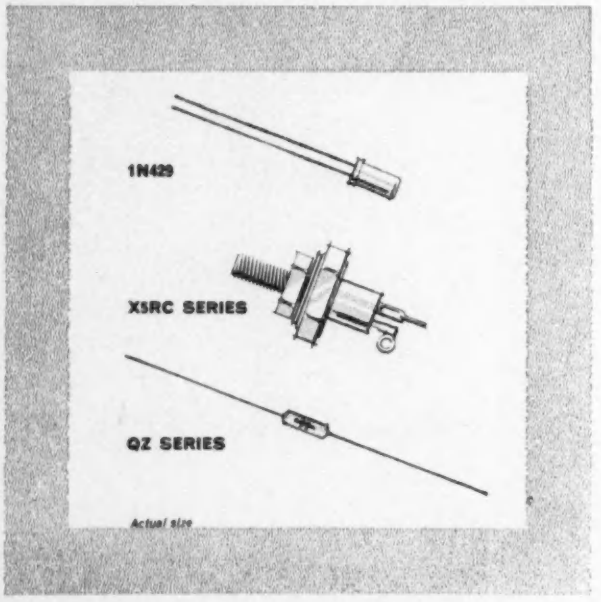
1N483A TO 1N488A

The all-new International Rectifier glass diodes, incorporating the latest silicon diffused junction techniques. Power dissipation of 0.250 watts at 25°C; 0.125W at 150°C. Operating temperature range —55°C to +200°C. Nominal frequency range 0 to 100 kilocycles. P.I.V. range 70 to 380 volts.

5A SERIES

A completely new series of diodes featuring a forward current rating of 1 amp and a P.I.V. range of 200 to 600 volts. The reverse current is only 200μA at 100°C case temperature, and the diode will handle a surge current of 50 amps for 1 cycle (60 c.p.s.). The case is non-metallic and the temperature range of the device is —65°C to +130°C. Oversize leads give added strength and eliminate heat sinks.

6 NEW SEMICONDUCTORS



1N429 VOLTAGE REFERENCE ELEMENT

A totally new miniature voltage reference element, 200mW rated, with a stability of ± 0.006%/°C or better over the temperature range —55°C to +100°C, but only 0.230" (max.) diameter x 0.36" long, excluding leads.

X5RC SERIES 5 AMP. CONTROLLED RECTIFIER

A new range of silicon controlled rectifiers available in a P.I.V. range of 50 to 400 volts. Rated at 5 amps, these devices have a surge rating of 60 amps for 1 cycle (60 c.p.s.) and have a forward voltage drop of only 0.8 volts.

QZ SERIES 250 mW ZENER DIODES

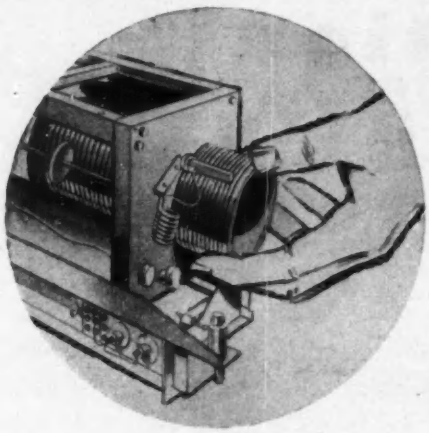
High stability and excellent voltage regulation over the temperature range from —55°C to +150°C is provided by this new range of glass zener diodes. Rated at 250mW they cover the range from 3.3 to 27 volts. They are available in ± 5% and ± 10% voltage tolerance.

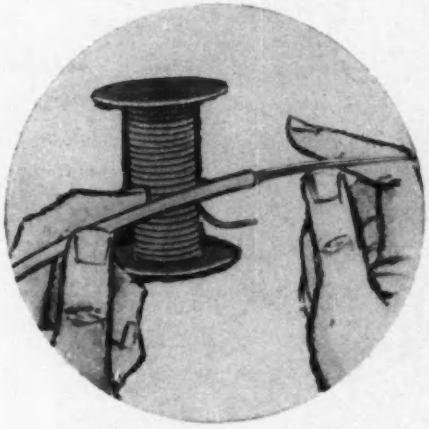
Write for bulletins SR-2012 and XSR-353.

INTERNATIONAL RECTIFIER COMPANY

(GREAT BRITAIN) LIMITED · OXTED · SURREY · Oxted 3215

Associate company of International Rectifier Corporation U.S.A. and the Metal Industries Group, Great Britain.





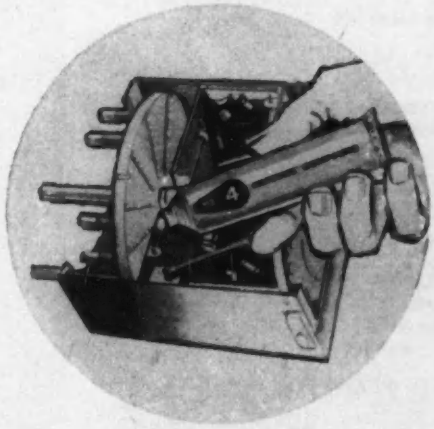
SILICONE ROUND-UP

MS Silicones are everywhere in electronics. Their virtuosity is based on three outstanding characteristics: EXCELLENT DIELECTRIC PROPERTIES, HEAT RESISTANCE and WATER REPELLENCY.

Silicone Glass Laminates . . . with high arc resistance and consistently low dielectric losses . . . **Cold-Cure Silastomer** . . . a liquid silicone rubber that sets at room temperature, encapsulates, seals and fills voids, serviceable from —50°C to +250°C . . . **Silicone Insulating Sleeving** designed for continuous operation up to 180°C . . . **Silicone Resins** for resistor coatings that are hard, heat-resistant and water repellent . . . and there's **MS 4, a non-melting grease,** excellent dielectric, highly water repellent, a preservative for rubber and plastics . . . ALL VERSATILE MS SILICONES for reliability and long operational life—in all types of electronic equipment.

MS Technical Service Department exists to advise you on problems that silicones might help to solve. Consult our team of experts who have a real understanding of the application of silicones in industry based on ten years of experience.

Write for detailed information on any one of the products mentioned here or for our new, illustrated booklet "Silicones in Electronics" (A 13).



MS were first in the field of British silicones, and this experience is reflected in every MS product.

MS

MIDLAND SILICONES LTD

(Associated with Albright & Wilson Ltd and Dow Corning Corporation)

***first** in British Silicones*

68 KNIGHTSBRIDGE · LONDON · SW1
TELEPHONE: KNIGHTSBRIDGE 7801

Area Sales Offices: Birmingham, Glasgow, Leeds, London, Manchester. Agents in many countries.

MSS 19

EE 40 094 *for further details*

radiation pattern recorder

TYPE EL41

Dimensions: 2 ft. × 2½ ft. × 3½ ft.

The instrument is designed to provide the engineer with the basic equipment required for the automatic plotting of aerial radiation patterns, in either cartesian or polar co-ordinates.

By using a servo-controlled piston attenuator to maintain a constant amplitude signal at an intermediate frequency, the calibration of the instrument is absolute and it can therefore be used on any frequency band, provided the appropriate mixer and local oscillator are fitted.

Automatic recording of radiation patterns speeds aerial development

Robust and compact construction permits installation in limited space

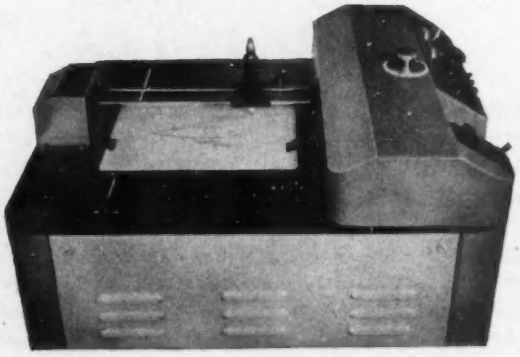
Signal required to operate recorder:
100% square wave modulated R.F. at a p.r.f. of 1 Kc/s

Maximum plotting range:
50 db cartesian
30 db polar

Maximum pen speed:
30 db/sec

Plotting scale:
2 db/cm

Cartesian table movement:
20 cm



Using the Barr and Stroud Aerial Turntable Assembly Type EL52, scales of 20°/cm, 10°/cm, 5°/cm and 1°/cm are available.

For further details please write for illustrated leaflet SD61.

BARR & STROUD LTD

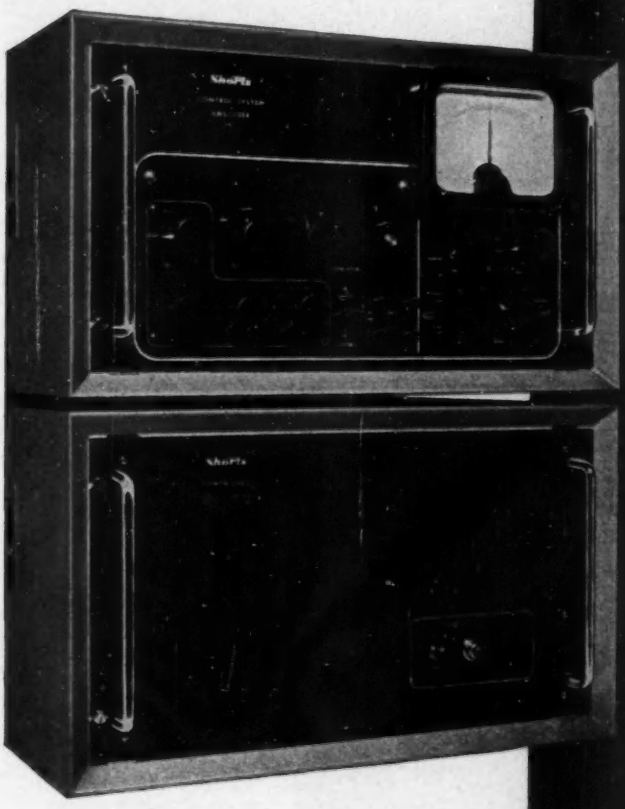
ANNIESLAND, GLASGOW, W.3

London Office: Kinnaird House, 1 Pall Mall East, S.W.1

EE 40 095 *for further details*

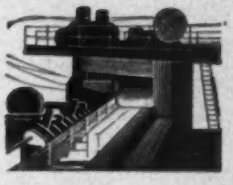
The *Short* Control System Analyser

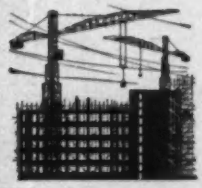
A new instrument for investigation of feedback control systems.
The Analyser incorporates the Short Low Frequency Oscillator.



- **Steady inphase and quadrature readings**
- **Complete rejection of system D.C**
- **Harmonic rejection**
- **D.C. content less than 0.0005%**
- **Sine and cosine distortion less than 0.5%**
- **Amplitude within ± 1%**
- **Frequency range 0.01—109.9 c/s within 1%**
- **Zero start and exponential finish to sine wave output**

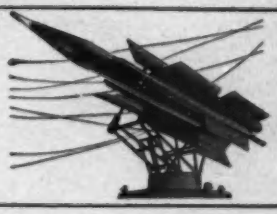
Control of rolling mill and mining machinery

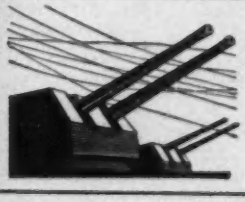




Design of heavy crane control gear

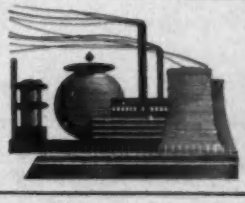
Missile servo analysis

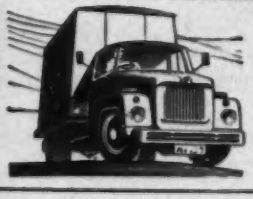




Gun control problems

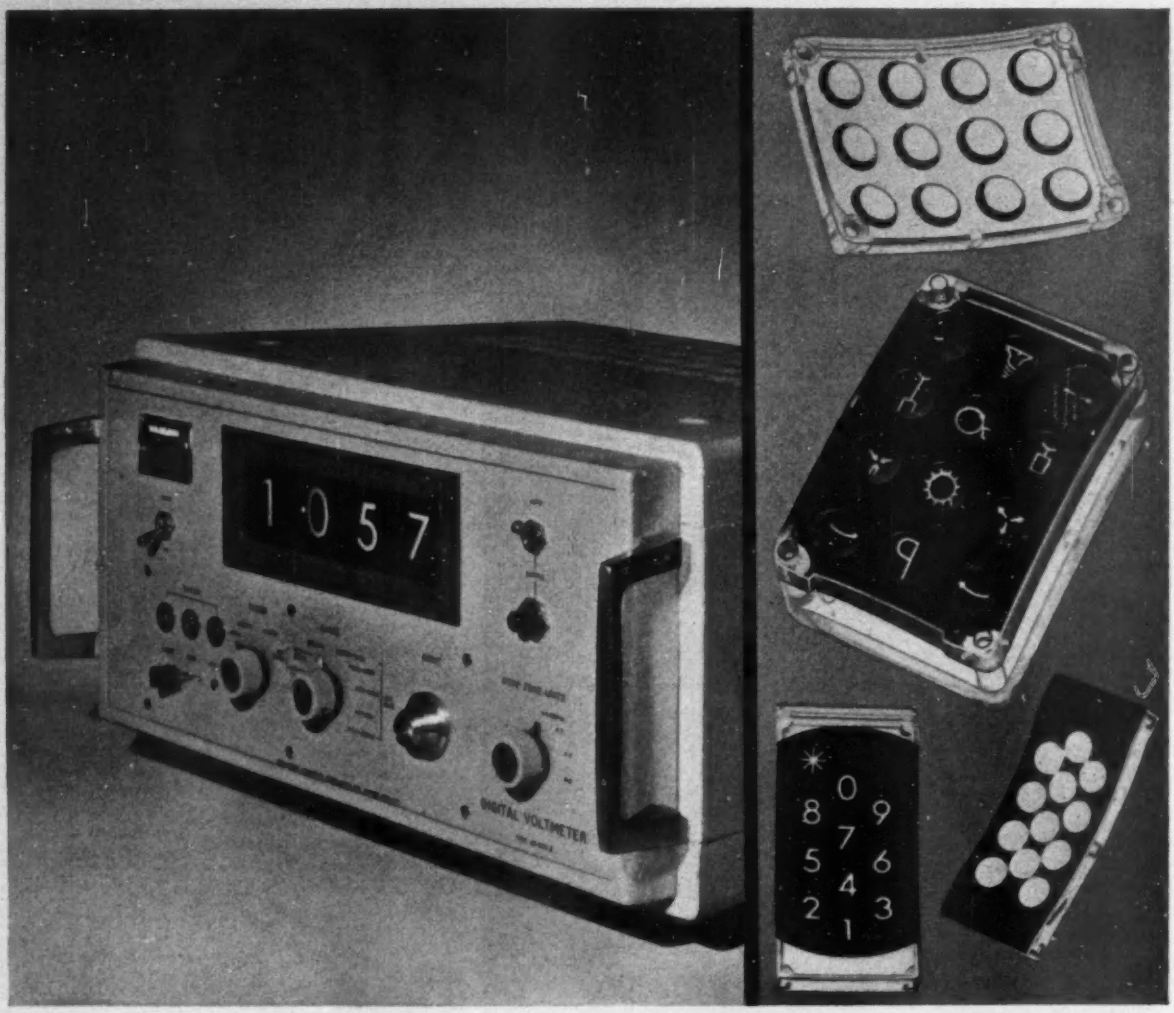
Reactor control mechanisms





Powered steering and damper design

Write for data sheet to:
COMPUTOR SALES DEPARTMENT SHORT BROTHERS AND HARLAND LIMITED East India House 208a Regent Street London W.1



Digital voltmeter made by Solartron Laboratory Instruments Limited, Chessington, Surrey, with digital units, condensing lenses and masks moulded from 'Diakon' acrylic polymer by Counting Instruments Ltd., Elstree Way, Boreham Wood, Herts.

'Diakon' Polymer cuts cost of high quality precision moulding

Because of its low initial cost and high efficiency as a moulding material, 'Diakon' acrylic polymer makes precision components such as these numbering wheels and condensing lenses available at economical prices.

'Diakon' moulded components have a high impact strength and a clarity and depth of colour available with no other moulding material. 'Diakon' is dimensionally stable, even in humid atmospheres or at high temperatures. It is resistant to staining by nicotine, polishes and chemical products.

More and more 'Diakon' polymer is being used in the manufacture of telephone handsets, T.V. implosion guards, lighting fittings and a host of other products. To learn more about the uses of 'Diakon' in your industry, please write to I.C.I.

'DIAKON' POLYMER

'Diakon' is the registered trade mark for the acrylic polymer manufactured by I.C.I.

ICI

DN11

IMPERIAL CHEMICAL INDUSTRIES LIMITED · LONDON · S.W.1

THESE 3 TMC SOLID STATE CIRCUIT ELEMENTS

PLUS *the transistorized chopper* *

All with

LONG LIFE • SHOCK-PROOF ENCAPSULATION • COMPACTNESS—only 1⅛" x 1¼" dia. **• COMPETITIVE PRICE • IMMEDIATE DELIVERY**

provide the pre-assembled stages of a complete D.C. amplifier

and separately have a wide variety of other applications

AMPLIFIER SA10

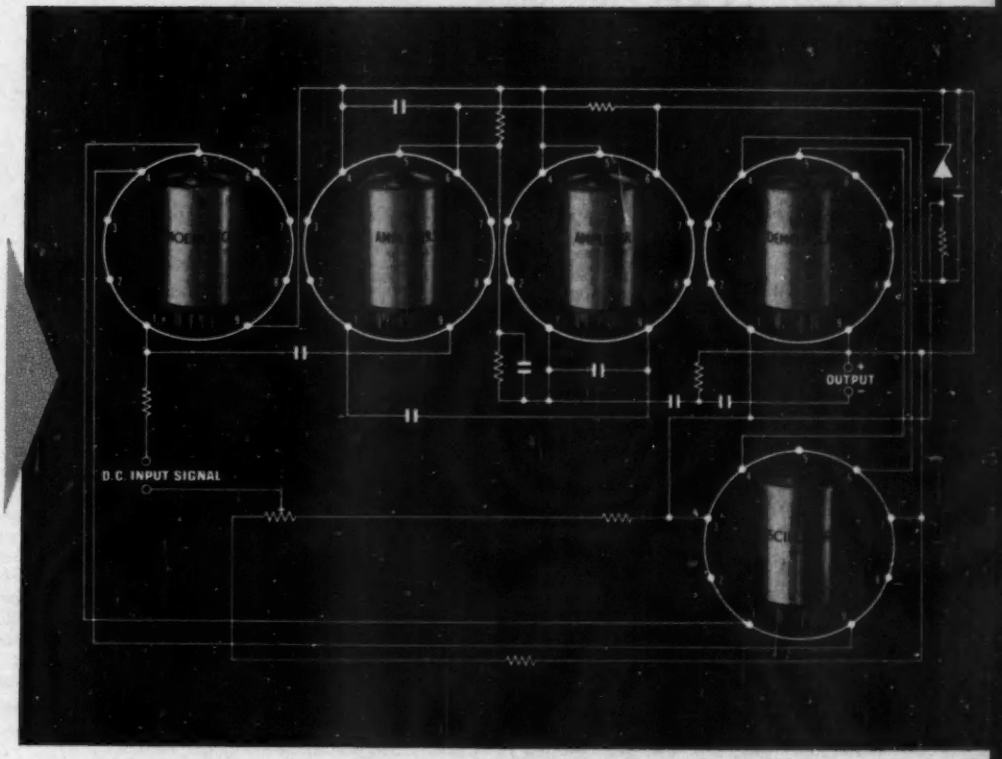
- a general purpose single stage amplifier for use in conjunction with other elements forming D.C. amplifiers in servo systems, computers etc. Nominal gain of 150 may be cascaded for greater gain with negative feedback. Impedance matched.

OSCILLATOR SO11

- provides driving voltage of rectangular wave-form for chopper and de-modulator. Frequency dependent on input voltage (maximum frequency exceeds 800 c/s).

DE-MODULATOR SD11

- post amplification complement to chopper. May be used as shunt clamp or series gate. Switches from d.c. to 1000 c/s (switching capacity of ± 60V at 2mA peak).



*** *What! You haven't heard about the new transistorized chopper?***

It's the Electronic Modulator SM10 recently launched by TMC - the first fully encapsulated transistorized chopper to be produced and sold in quantity in Gt. Britain. Briefly, it is a highly stable, long life, fully encapsulated chopper. Its noise level is so low that it can actually chop a 1 microvolt signal. Chopping speed up to 1000 c/s.

All four solid-state circuit elements (transistorized wherever possible for maximum compactness and reliability) are designed and manufactured by Bailey Meters & Controls Ltd. (patents applied for). They are marketed throughout the world by TMC.

Price lists, full technical details and TMC's comprehensive sales and advisory service await your request—so please act now!

TMC

TELEPHONE MANUFACTURING COMPANY LIMITED

Dept B · Martell Road · West Dulwich · London SE21 · Tel: Gipsy Hill 221

A MEMBER OF THE PE GROUP OF COMPANIES

EE 40 098 *for further details*

A WORLD OF VIBRATION

Vibration technology is a comparatively new development in the field of environmental engineering. Its applications in measuring metallurgical stresses and strains, in simulating fatigue to destruction point, are fairly well-known, but even the present scope is far wider than these. The potential is immense to a degree which possibly outreaches that of any other applied science. It is even possible that there is much to be rediscovered, for the histories and mythologies of ancient civilizations abound in references to physical motion achieved through sound vibrations. The destruction of the walls of Jericho is an example; and it has been suggested that the Pyramids' vast masonry was elevated by similar means. But fascinating and perhaps revealing as that line of inquiry may be, this report will deal principally with the immediately practical uses of vibration testing.

From eyes to motor cars is an apt and related part of the applications range. Taking the first and uncomfortably picturesque example, an incidence of severe headaches and impaired vision suffered by transport drivers led to tests with vibration equipment. These showed that through vibration on certain road surfaces, the drivers' eyes were being literally bounced back and forth in their sockets.

MOTOR VEHICLE INDUSTRY

Car bodies and their attachments are subject to mechanical and other vibrations transmitted through suspension systems. What with wear and tear and varying concern for maintenance, the noises which can result are an age-old problem at the service station. The drumming heard by the owner 'under the back seat somewhere' is usually non-existent in normal workshop testing; out on the road it's audible but locating it is a tedious and uneconomic guessing game.

Yet further complications arise out of the fact that the vibration source may be far removed from the apparently offending component or structure.

We have a compact generator/oscillator/power amplifier combination by which all the running vibrations can be simulated *in the workshop* and the noise source accurately and quickly located. Similar equipment is used by car manufacturers so that vibrations can be compensated or designed out.

ROAD CONSTRUCTION

Roads, too, can be investigated with vibration equipment. An applied vibration is picked up at a distance, on an oscilloscope. The signal time and strength factors vary according to the nature and thickness of the surface and subgrade materials. By these readings it can be determined whether or not the construction is according to specification. Periodic tests will reveal the extent of any deterioration. In research, the behaviour of roads under various traffic conditions can be established and the information used in framing specifications for new roadworks.

AIRCRAFT INDUSTRY

In the aircraft industry, vibration testing has long been a vitally important technique. Bearing in mind the possible outcome of the failure of quite small components, vibration problems in land vehicles and structures pale into comparative insignificance. Goodmans equipment is widely used to test dynamic models . . . even whole aircraft . . . and on the multiplicity of instruments and electronic apparatus.

The tremendous power and complexity of rocket-propelled vehicles set still more exacting requirements and for these Goodmans are producing special generators.

OTHER APPLICATIONS

The miscellany of these is far too extensive to catalogue here, but the following will serve to demonstrate the scope.

In fatigue testing, vibration generators provide wide range and prolonged consistency.

Chemical and bio-chemical research are served by our smallest generator, the V47, in mixing, emulsifying and the measurement of interface potentials. It has been used also to simulate nerve signals and to assess vibration effect on living tissue. Experiments show that physical vibration and 'white noise' have anaesthetic properties.

Vibration equipment is used in the rubber, plastic and textile industries, as an aid in establishing the materials' mechanical properties.

Experiments in the machine tool industry have shown that small and carefully controlled vibrations can, in fact, improve stock removal, surface finish and minimize the effect of certain operations upon molecular structure.

This is inherently a world of movement. Everything vibrates within itself and often as an entity. These forces can be observed, reproduced, supplemented. There must therefore be many functions for our vibration equipment which even we can only guess at . . . and even more as yet unthought of. Name your problem; consider what may be done better, faster, more economically . . . what may be done perhaps for the first time, with the help of vibration equipment. It's more than likely that the means to the end is ready-made.

Goodmans electro-mechanical vibration generators, the largest range in Europe, comprise:

TYPE	PEAK THRUST
V47	2 lb
390A	17 lb
790	35 lb
8/600 Mk.II	300 lb
VG109 Mk.III	18,000 lb

There is available a corresponding range of oscillators and power amplifiers

GOODMANS
the vibration specialists

GOODMANS INDUSTRIES LTD. AXIOM WORKS, WEMBLEY, MIDDLESEX ENGLAND Wembley 1200 (8 lines) Cables: Goodaxiom, Wembley, England

Accredited Agents: HAWNT & CO. BIRMINGHAM · FARNELL INSTRUMENTS LTD. WETHERBY YORKS · A. R. BOLTON & CO. LTD. EDINBURGH

GD650

'ENGLISH ELECTRIC' VAPOUR COOLED POWER TRIODES

The range of vapour cooled power triodes by the **English Electric Valve Company Limited** now comprises five standard production types, for r.f. heating and telecommunications equipments, with anode dissipations from 10 to 50 kW.

Vapour cooling, under certain operational conditions, offers positive advantages over other available forms of cooling.

- ★ **Eliminates the need for costly air-filtration in dirt-laden and polluted atmospheres.**
- ★ **Effects substantial savings where water costs are high.**
- ★ **Can be operated where water is scarce.**
- ★ **Ensures completely silent operation.**

Abridged data are given here. For full information on these vapour cooled valves and their water and air cooled variants please write to the address below.

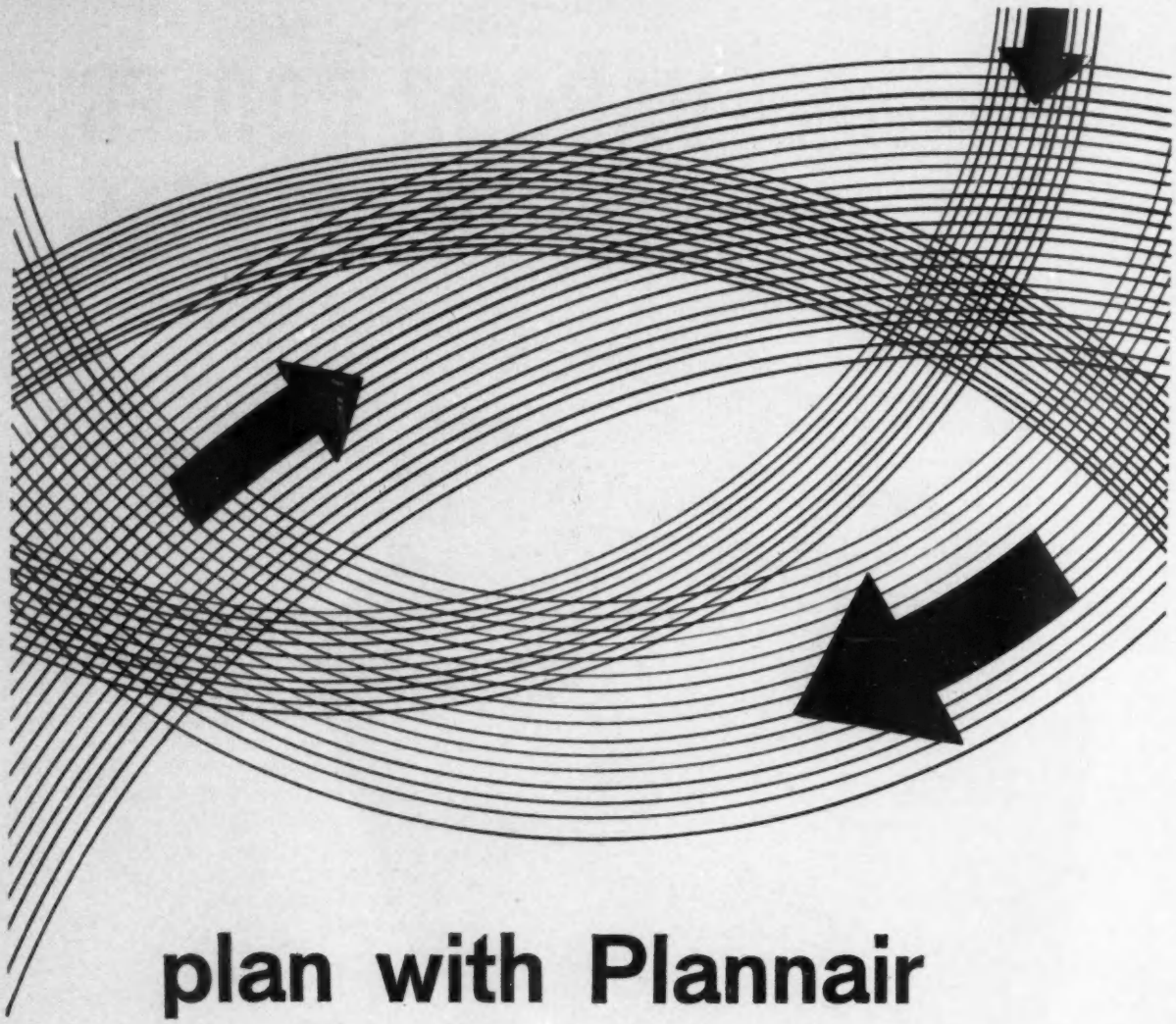
E.E.V. Type	Frequency (Mc/s)	Anode Voltage (kV)	Anode Dissipation (kW)	Output Power (kW)
BY189	20	12	35	82
BY194	5	15	50	159
BY1102	50	12	25	53
BY1121	50	10	18	50
BY1122	5	12	10	29

ENGLISH ELECTRIC VALVE COMPANY LTD.

Chelmsford, England. Telephone: Chelmsford 3491 | AGENTS THROUGHOUT THE WORLD.

AP 168

EE 40 100 *for further details*



plan with Plannair

Make Plannair a member of your own design team. Many manufacturers requiring temperature control by planned air movement are realising the need to consider this special problem at an early stage—and are calling in Plannair, the air movement specialists, to sit in on their first planning meetings.

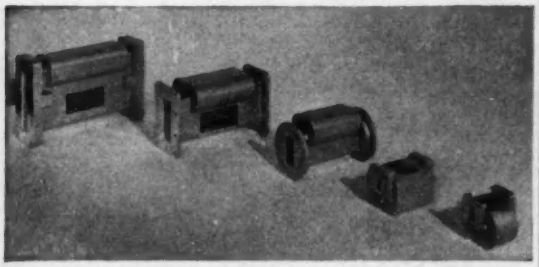
The strength of Plannair lies in the ability of its design engineers to solve complex air movement problems and to design blowers which will provide the right amount of air in the right place for temperature control in specific projects. Size, weight and performance are the prime considerations and these are skilfully balanced in every designed-for-purpose Plannair Blower.

Plannair Limited, Windfield House, Leatherhead, Surrey Tel: Leatherhead 4091

PLANNAIR

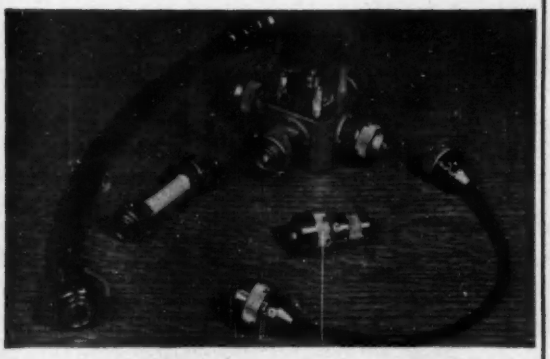
PLA64

Ferrite Isolators



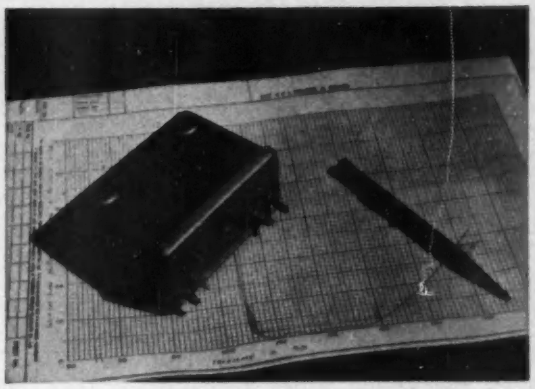
Existing Marconi designs cover most of the frequencies from 1.8 Kmc/s to 10 Kmc/s, and enable the following performance characteristics to be obtained :
Reverse losses of 45 dB or greater VSWRs 1.03.
Forward losses of 0.5 dB or less.
A wide range of ferrite devices, including circulators, is available; if your requirements fall outside our existing range we shall be pleased to consider a design to suit you.

50 ohm Coaxial Connectors



Designed to combine low VSWR with positive mechanical connection at 5000 mc/s, this connector is unique in its use for laboratory measurements and for any application calling for a stable and reliable match. Alternative arrangements are available for flexible cables or panel mounting use. The connectors are normally female but can be converted to male by the simple addition of a locating ring and connecting pin. The design incorporates a sealing ring for waterproofing the connecting joint.

Miniature Crystal Filters



Crystal filters operating at 100 kc/s with bandpass characteristics.
Pairs of upper and lower sideband selection filters for SSB applications.
IF filters at 455 kc/s.
Marconi's are constantly engaged in the development of new crystal filter techniques, and it is impossible to specify the large number of filter designs available. The Company's unique experience in this field enables us to offer advice and technical assistance with filter problems of any kind.

MARCONI

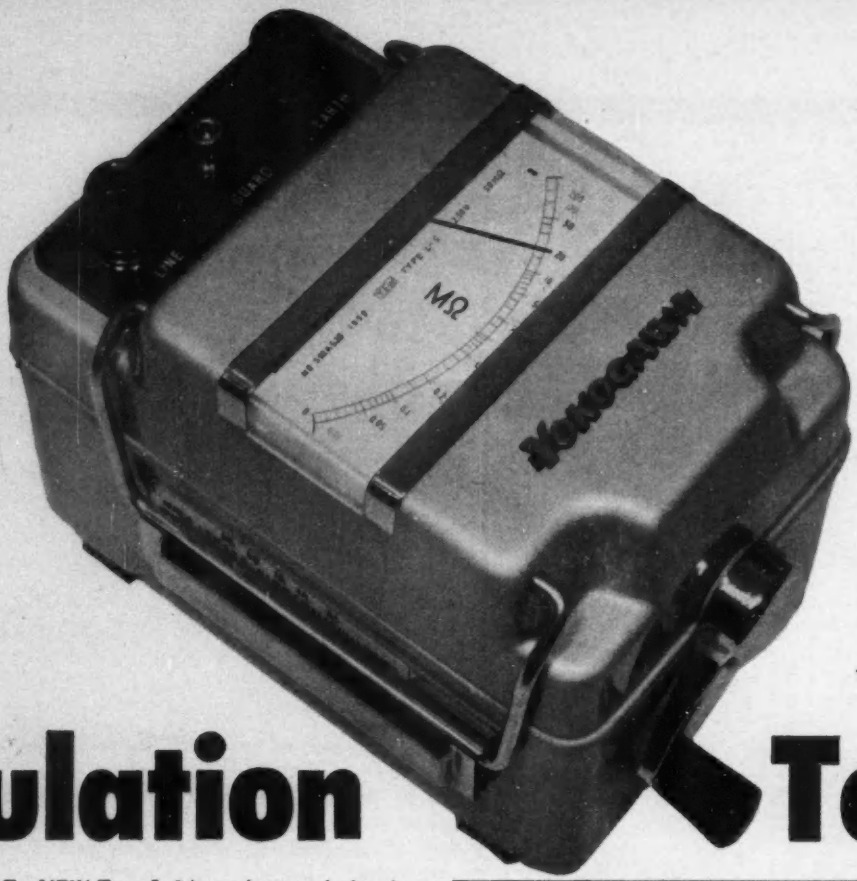
SPECIALIZED RADIO COMPONENTS

Write for details of crystal filters and other specialized components to :

SPECIALIZED COMPONENTS GROUP

MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, CHELMSFORD, ESSEX, ENGLAND

A preliminary catalogue is available listing specialized components for immediate delivery.



Type L-5

Insulation Tester

EXPANDED SCALE YEW Type **L-5** has a long and electrically expanded scale which covers 5 decades of resistance.

QUICK RESPONSE The quick response of Type **L-5** will help you read the insulation resistance instantly.

SILENT GENERATOR The rotary magnet type generator turns extremely smooth and silent because of its excellent dynamic balance.

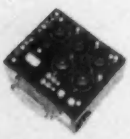
CORE MAGNET SYSTEM INDICATOR The indicator employs a core magnet system in which the yoke acts as a self-shield to minimize the external field influence.

GOOD DESIGN YEW Type **L-5** has a graceful appearance with gray colored aluminum case with a wide window.

Type	Rated Voltage / Rated Resistance	Range			Effective Measuring Range
L-5	100V / 20M Ω	0~∞Ω	Lowest scale line	2k Ω	0.02~20M Ω
			Highest scale line	100M Ω	
	250V / 50M Ω	〃	〃	0.01M Ω	0.05~50M Ω
			〃	200M Ω	
	500V / 100M Ω	〃	〃	0.01M Ω	0.1~100M Ω
			〃	500M Ω	
	500V / 1,000M Ω	〃	〃	0.1M Ω	1~1,000M Ω
			〃	5,000M Ω	
	1,000V / 2,000M Ω	〃	〃	0.5M Ω	2~2,000M Ω
			〃	10,000M Ω	
L-5 B	2,000V / 5,000M Ω	〃	〃	0.5M Ω	5~5,000M Ω
			〃	20,000M Ω	

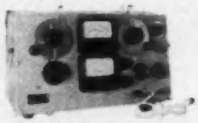
Portable Instrument

Panel Instrument



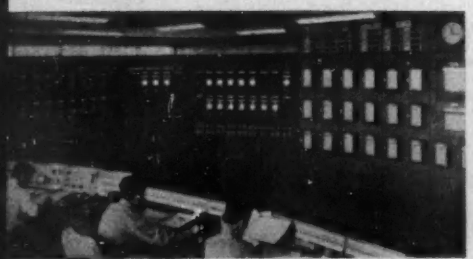
Wheatstone Bridge

Earth Resistance Tester

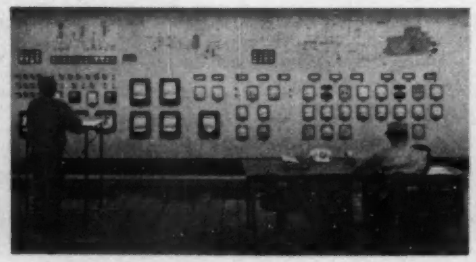


Q-Meter

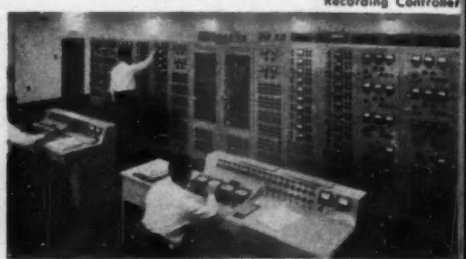
All-Electronic Recording Controller



Economic Load Dispatch Computer



Central Control Station of Chemical Plant



All-Electronic A.C. Network Analyzer

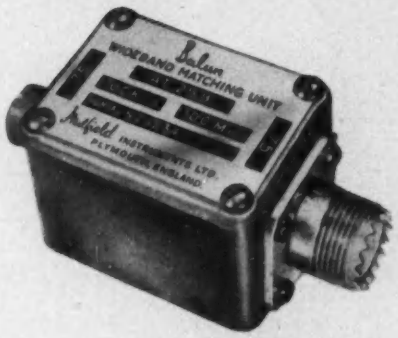
YOKOGAWA ELECTRIC WORKS, LTD.

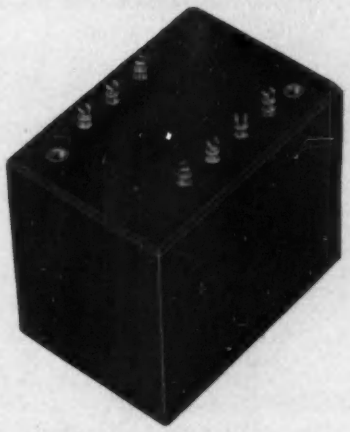
YEW

Leaders in Electrical Measuring Instruments for 50 years

Head Office: 3,000 Kichijoji, Musashino-shi, Tokyo, Japan New York Office: YOKOGAWA ELECTRIC WORKS, INC., 40 Worth St., New York, N.Y.
U. K. Sales Agents for Insulation Testers: THE ELECTRICAL INSTRUMENT CO., LTD., Boswell Square, Industrial Estate, Hillington, Glasgow, S.W. 2
Sole Distributor in Australia: FOXALL INSTRUMENTS PTY. LTD., 1213-1217 High Street, Armadale, S.E. 3, Melbourne
Sole Distributor in Taiwan: YUNG HO COMPANY, LTD., 38 Kwan Chen Road, Taipei, Taiwan

For aperiodic matching ... no tuning devices or resonant circuits

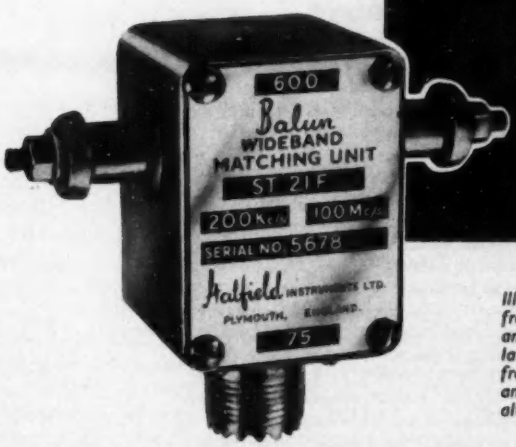




Developed as a result of long research into the design of wide band transformers for use at radio frequencies, these units are ntended for applications where optimum power transfer is required between any source of a given impedance and a load having a different impedance, and for connecting co-axial systems to circuits which are balanced with respect to earth. **The units provide a simple means of matching balanced aerials to co-axial systems, with the advantage of being aperiodic over any band which may be encountered in a single aerial, without the necessity for tuning devices or resonant circuits.**

A wide range is available offering a variety of choice of frequency spectra and impedance levels at economic prices. Arrangements can be made for the development and production of special types to meet individual needs.

BALUN wide band Transformers



Illustrated above are: Type AT 25B from the range 100 kc/s to 100 Mc/s, and one of the VT Series, encapsulated in high quality synthetic resin from the range 25 c/s to 2 Mc/s: and, left, Type ST 21F showing alternative feed arrangement.

- Three basic frequency ranges:
  25 c/s to 2 Mc/s
  100 k/cs to 100 Mc/s
  3 Mc/s to 300 Mc/s
- Other types up to 1,000 Mc/s available
- Choice of six balanced output impedances from 50 to 600 ohms
- Insertion loss never greater than 3dB
- Balance ratio always better than 20 dB

Write today for fully detailed reference sheets, or ask for a Technical Representative to call.

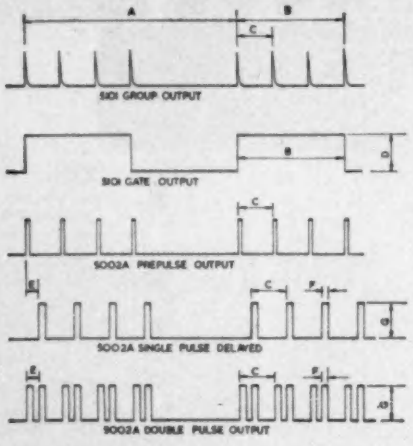
HATFIELD BALUN

HATFIELD INSTRUMENTS LTD.
DEPT. EE, BURRINGTON WAY, PLYMOUTH, DEVON.

Telephone: Plymouth 72773/4.

a new square wave and pulse group generator

MODEL **5101**

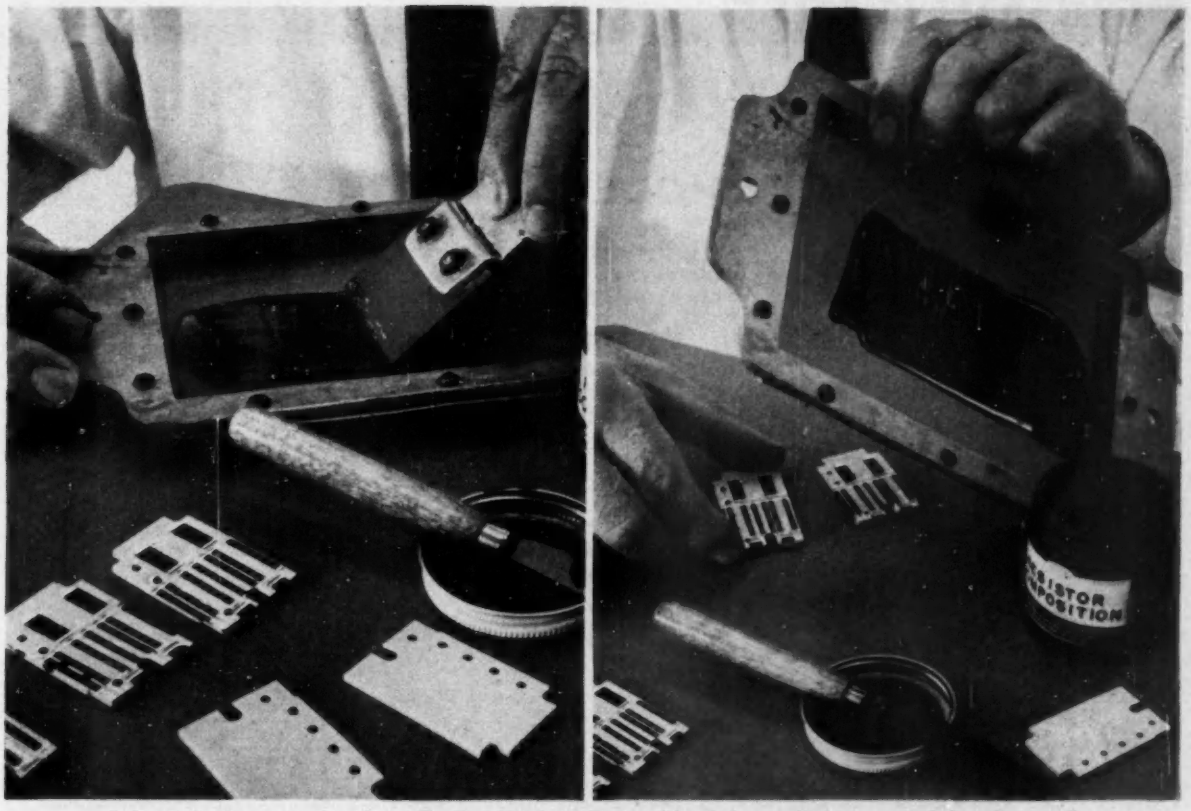


A= 1–100,000 GROUPS PER SEC.
B= 5μ SEC. TO 0·5 SEC. GROUP LENGTH
C= 10c/s–1M·c/s FREQUENCY IN GROUP
D= SQUARE PULSE 100mV–100V POSITIVE GOING
E= 0·2μ SEC. TO 2 SEC. DELAY
F= 2μ SEC. TO 1 SEC. PULSE WIDTH
G= 200μV–50V POSITIVE OR NEGATIVE

A study of the diagram may suggest how this instrument can be of use in your specific problem.
Calibrated and continuously variable groups of pulses, plus square wave output of continuously variable amplitude 100μV to 100 volts. Versatile triggering system, external or internal. Single groups of pulses by push button. For use with the NAGARD 5002 Double Pulse Generator or any other generator capable of being externally triggered.
IDEAL FOR COMPUTER TESTING by providing a simulated programme of pulses controllable in a great variety of ways.
If you already have a Nagard 5002 Pulse Generator the 5101 will extend its usefulness, besides being a good square wave generator and triggering device when used by itself.
Ask for data sheet No. 6610 on 5101
" " No. 1060 on 5002

18 AVENUE ROAD · BELMONT · SURREY
Tel: VIGilant 9161-2

NAGARD LTD



Laboratory demonstration shows Du Pont Resistor Composition being applied to a ceramic base by stencil screen and squeegee (left). When stencil is removed from ceramic base, resistor is ready for firing (right).

New Du Pont Resistor Compositions are easy to apply... permit you to vary resistance values by blending the compositions

One major advantage of Du Pont Resistor Composition is its ease of application on ceramic or glass substrates. Just a simple screen-print, dip, brush or spray application, and the resistor is ready for firing under normal atmospheric conditions in the range of 1100-1400°F.

Du Pont resistor compositions allow you to vary resistance values by changing the composition of the resistor without altering its geometric form. You are no longer limited by the physical shape of conventional resistor materials. These compositions give you greater design flexibility, essential for miniaturized circuits. They are available at three approximate resistance values: 500, 3,500 and 10,000 ohms/sq. per mil thickness, and they can be blended to give a range of intermediate values.

Electrical properties are reproducible. Laboratory tests show that fired printed patterns and coated rods have abrasion and impact resistance similar to fired silver coatings.

Du Pont does not manufacture resistors . . . only resistor compositions. For further information please write to the U.K. distributors:

BROWN & FORTH LTD.
CLIFTON HOUSE, EUSTON ROAD
LONDON N.W.1

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

DU PONT
REG. U.S. PAT. OFF.

Perhaps you can also profit from these Du Pont products for the Electronics Industry

Conductive Coatings: Specially compounded silver, gold, palladium and platinum compositions that are used to produce capacitor electrodes, ceramic-to-metal hermetic seals, electrical shields and surfaces of high conductivity on non-conductive materials.

Conductive Cements: Silver and gold compositions consisting of finely divided metallic particles dispersed in a resin system; Du Pont conductive cements may be used to replace solder as lead attachments for transistors, diodes, resistors and as a base for electroplating.

EE 40 106 *for further details*

NOW AVAILABLE with full details from UK representatives

WALMORE ELECTRONICS

COLD CATHODE RELAY TUBES

CERBERUS A. G. Switzerland, specialise in cold cathode tubes. Relay tubes are available for a wide variety of applications—control circuits, timers, photo-electrics, etc.

FEATURES of these CERBERUS types
Long life (in excess of 25,000 hours)—Stability—
Narrow tolerances—Self indication of switching state—
Types to work off the AC supply line.

BRIEF DETAILS

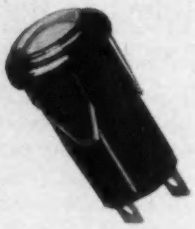
TYPE	ELECTRICAL CHARACTERISTICS			BRIEF DESCRIPTION
	SUPPLY VOLTAGE	STARTER BREAKDOWN	CURRENT RANGE	
GR 15	220V DC	120-140V DC	10-40mA	Noval 1 Starter
GR 16	220V AC	85-100V AC	10-40mA	,, 1 Starter
GR 17	220V AC	120-150V AC	5-40mA	,, 1 Starter
GR 19	220V DC	135V DC	4-20mA	,, 1 Starter for very low control current
GR 20	220V DC	120-140V DC	4-30mA	Noval 2 Starters
GR 21	230V DC	130-155V DC	2.5-8mA	Submin 2 Starters
GR 31	300V DC	125-140V DC	10-40mA	Noval 1 Starter
GR 41	300V DC	120-140V DC	4-10mA	Submin 2 Starters

CERBERUS

NEON INDICATOR UNITS

To operate directly off the AC supply with built-in resistor—Quick and easy to mount and connect. Available in range of colours—Clear—Opal—Red—Green—Yellow—Blue.

Type SGF
Curved Face



Type SGFF
Flat Face

VARIABLE VACUUM CAPACITORS

BY **VACAP** CORPORATION

Pyrex Glass
OFHC copper seals

Types for—
CAPACITANCES UP TO 500pF
CURRENT 42 amps r.m.s.
VOLTAGES up to 30KV

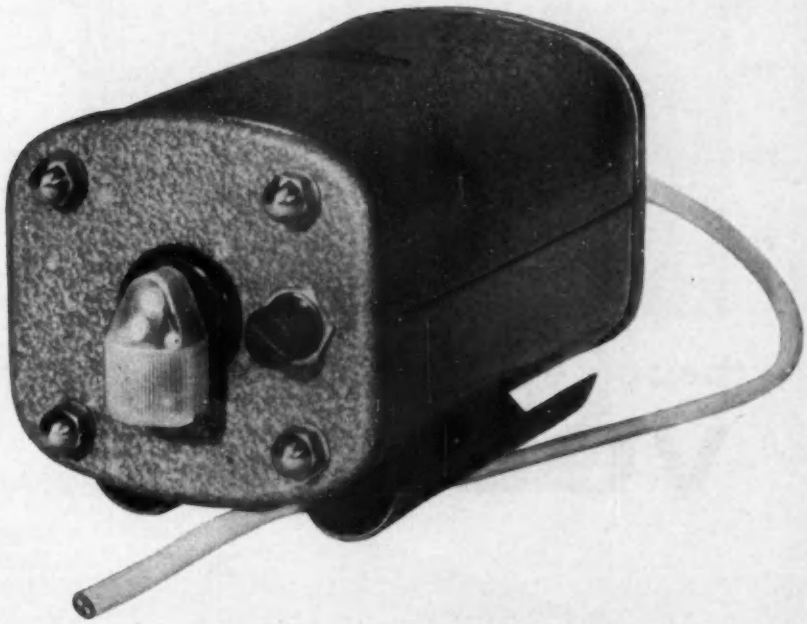
WALMORE ELECTRONICS LIMITED

representing and advising on the products of....

EITEL-McCULLOUGH INC. CALIFORNIA U.S.A.	MOTOROLA SEMICONDUCTOR PRODUCTS INC. ARIZONA U.S.A.	TUNG-SOL ELECTRIC INC. NEW JERSEY U.S.A.
CERBERUS AG. SWITZERLAND (cold cathode tubes)	NATIONAL ELECTRONICS INCORPORATED ILLINOIS U.S.A.	VACAP CORRORATION NEW JERSEY U.S.A.

WALMORE ELECTRONICS LIMITED, 11-15 BETTERTON STREET, DRURY LANE, LONON, W.C.2
Telephone: TEMple Bar 0201/5. Telex: London 28752

A new inexpensive, portable and attractive range of Auto, isolating and low voltage transformers for domestic or single-unit industrial use. Standard models are available for 230-250 v. input and 240, 110, 24 and 12 v. output (other voltages can be made to order).



Gardners

CASTLE SERIES

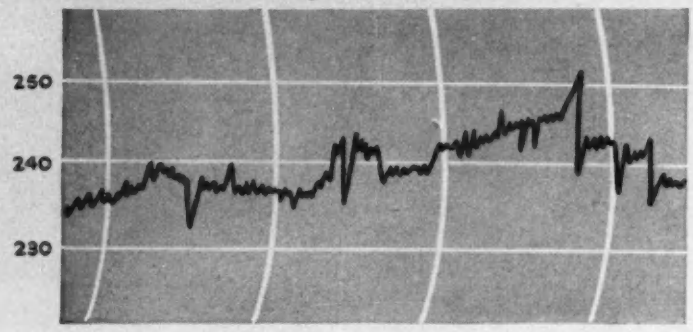
TRANSFORMERS

22 standard double wound ratings and 9 auto wound are now listed, with dimensions, weights and prices in Gardners Industrial and 'SM' (Private users) Catalogues. Existing registered holders of the Industrial Catalogue have been supplied with Amendment Sheets covering the new Castle Series.

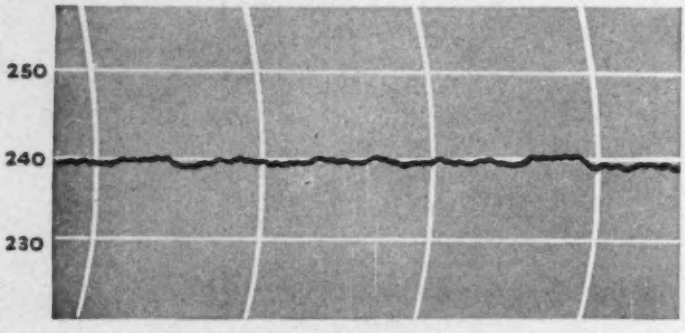
GARDNERS RADIO LTD., SOMERFORD, CHRISTCHURCH, HANTS. Tel.: CHRISTCHURCH 1734

EE 40 108 *for further details*

This recording is typical of line voltage conditions in an industrial establishment where voltage variation is a problem.

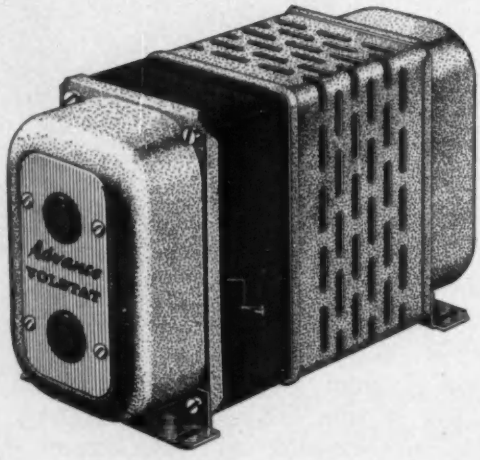


FLUCTUATING VOLTAGE



becomes constant with a

VOLSTAT



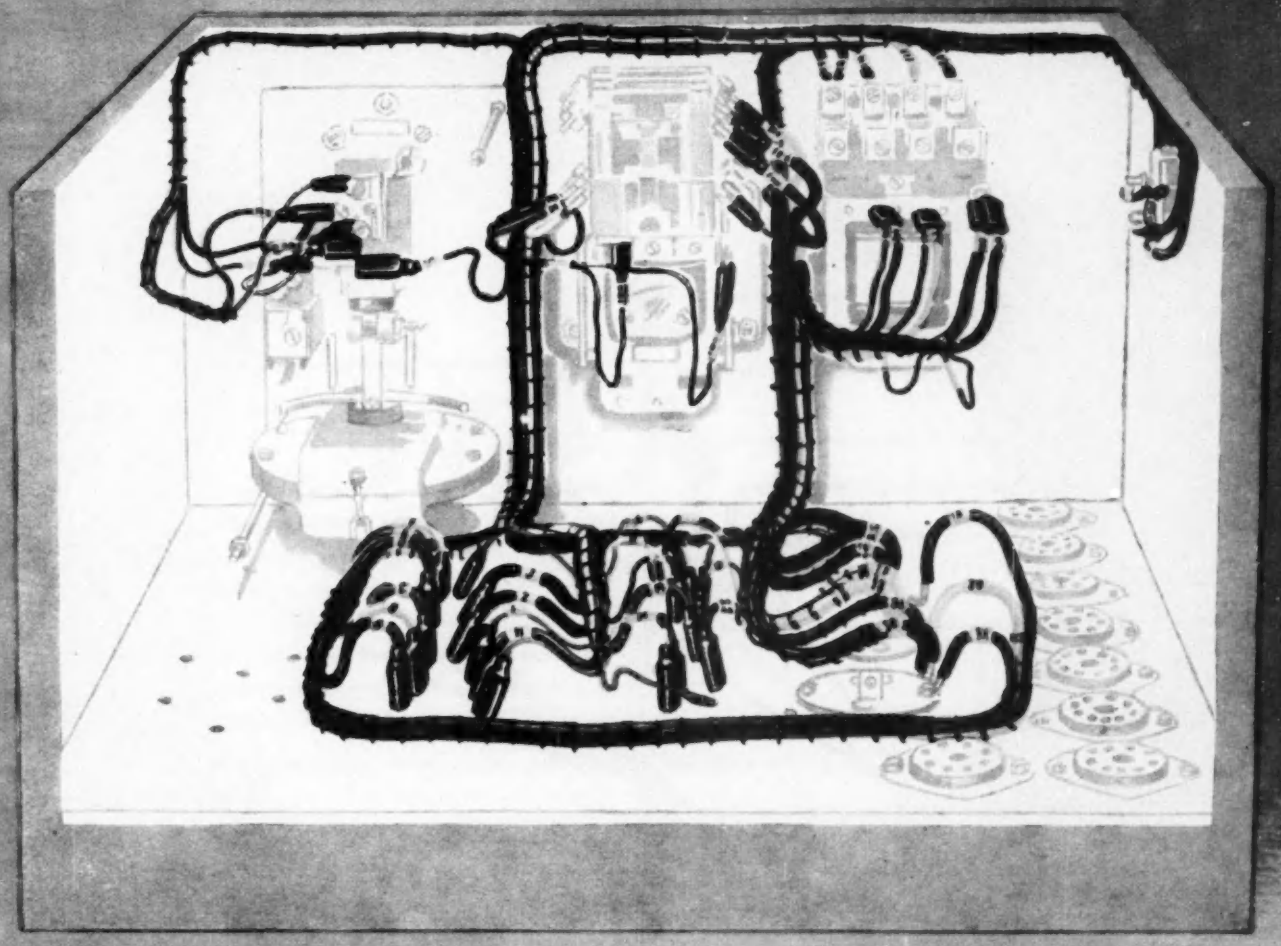
A VOLSTAT is the answer to many voltage fluctuation problems. In most cases, a standard type is all that is required—but there are occasions when a special design may be necessary. Either way, an 'Advance' Technical Representative will be pleased to investigate your own particular problems, and recommend a VOLSTAT best suited to your needs. VOLSTAT stands for a complete range of Constant Voltage Transformers produced by 'Advance'—the leading authority on voltage stabilization. Full details in Folder D63 available on request.

Advance **COMPONENTS LIMITED**

MAINS STABILIZATION DIVISION
ROEBUCK ROAD · HAINAULT · ILFORD · ESSEX · HAINAULT 4444

SBVC/2

RIST'S SIMPLIFY WIRING



BY SUPPLYING PRE-FORMED HARNESSES AS COMPLETE WIRING UNITS

- Moulded electrical assemblies
- Approved electrical cables for aircraft
- Cables for airborne and ground electronic equipment
- Industrial cables and flexibles

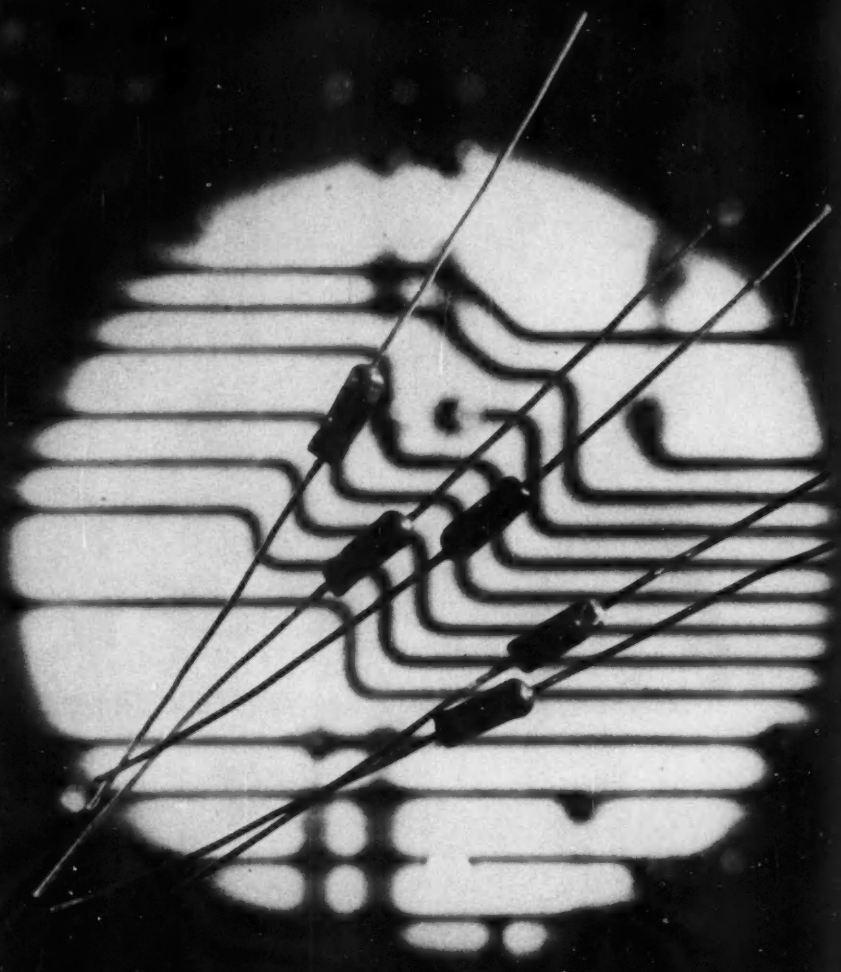
Please write for our leaflet

RIST'S WIRES & CABLES LTD

LOWER MILEHOUSE LANE · NEWCASTLE · STAFFS

AEI focus on . . .

MINIATURE ZENER DIODES



OUTSTANDING FEATURES

★ LOW CURRENT DRAIN
★ SMALL SIZE AND LOW WEIGHT
★ PREFERRED VOLTAGE TYPES
★ DOUBLE-ENDED ALL-GLASS CONSTRUCTION
★ HERMETIC SEAL

For COMPUTERS, DATA PROCESSING, INSTRUMENTATION, CLIPPING CIRCUITS, GENERAL VOLTAGE LIMITING and similar applications.

ADVANCE INFORMATION

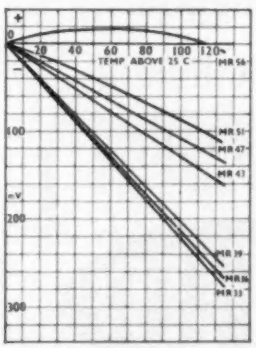
FEATURES—common to all these AEI Miniature Zener Diode Types

All glass encapsulation with sub-miniature construction . . . Hermetic sealing enables these diodes to be used in a wide range of environmental conditions . . . Rigidity of assembly and small size enable all types to withstand severe mechanical vibration and shock.

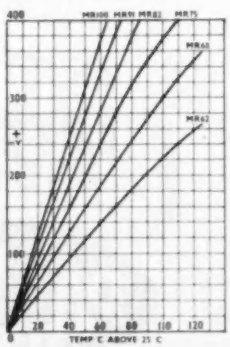
Diode Type	Zener voltage at 5 mA 25 C			Dynamic Slope resistance at 5 mA 25 C		Leakage current at 2V 100 C		Maximum Continuous Reverse current at 25 C mA
	Min. V	Typ. V	Max. V	Typ. Ohm	Max. Ohm	Typ. μA	Max. μA	
MR 33 H	3·1	3·3	3·5	90	100	250	600	50
MR 36 H	3·4	3·6	3·8	86	95	80	200	47
MR 39 H	3·7	3·9	4·1	80	90	35	100	44
MR 43 H	4·0	4·3	4·5	72	85	13	50	42
MR 47 H	4·4	4·7	5·0	62	80	3·0	30	40
MR 51 H	4·8	5·1	5·4	50	70	1·0	30	38
MR 56 H	5·3	5·6	6·0	25	50	0·6	10	35
MR 62 H	5·8	6·2	6·6	10	30	0·4	10	33
MR 68 H	6·4	6·8	7·2	3·7	15	0·85	10	29
MR 75 H	7·1	7·5	7·9	4·0	15	1·25	10	27
MR 82 H	7·7	8·2	8·7	5·5	20	1·5	10	25
MR 91 H	8·6	9·1	9·6	8·0	20	2·0	10	23
MR 100 H	9·4	10·0	10·6	11·0	30	2·0	10	21

	Forward volt Drop at 5 mA			Typical forward Slope resistance at 5 mA	Capacitance at −2 volts			Maximum Continuous forward current at 25 C mA
	Min. V	Typ. V	Max. V	ohms	Min. pF	Typ. pF	Max. pF	
All above types	0·67	0·71	0·73	6·3	100	275	700	225

DIMENSIONS similar for all types



Typical change in reference voltage at 5 mA with temperature



Typical change in reference voltage at 5 mA with temperature

PLEASE DON'T TEAR OUT THIS ADVERTISEMENT

—others will want to see it . . . If you would like to receive full details of these or any other AEI electronic components, all you have to do is write to AEI at the address below. Data sheets with detailed information will be sent to you without charge.

HELP YOURSELF! *Make sure your name is on our mailing list to receive advance information on all new AEI components. Don't delay—write* NOW!

AEI **Associated Electrical Industries Limited**

ELECTRONIC APPARATUS DIVISION · VALVE & SEMI-CONDUCTOR SALES DEPT.
CARHOLME ROAD · LINCOLN TEL: LINCOLN 26435

MINIATURE ZENER DIODES

Panellit's experience counts!

Panellit maintains lead in industrial data processing with SOLID-STATE data processor

NOW—a fully solid-state Data Processor from Panellit—a pioneer company in industrial data processing—with many years of invaluable experience in that field.

Incorporating Panellit's MINILOG transistorised logic this company now offers *the most reliable, flexible and easily maintained system available today.*

Modular design allows automatic data handling with data acquiring, data logging and alarm scanning facilities to individual requirement.

data logging
alarm scanning
data acquisition

PANELLIT

An experienced team of design application engineers is at your service and will be glad to advise you

Get to know Panellit

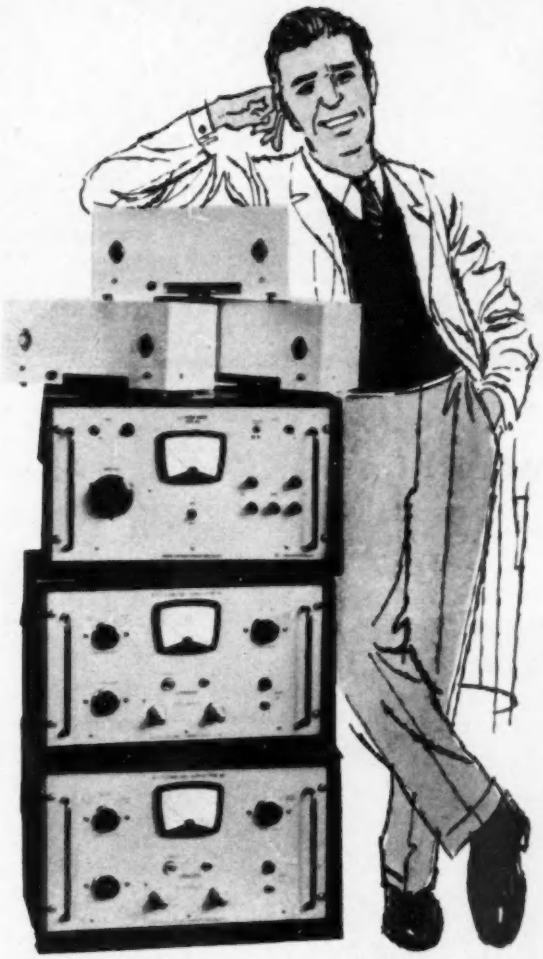
For full details please write to

PANELLIT LIMITED

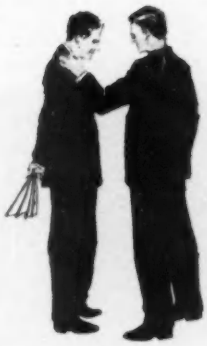
Elstree Way, Borehamwood, Herts. Elstree 2040

EA *A member of the Elliott Automation Group*

P.11



Microcell Power Supplies cover the range from 1 to 3000 Volts



microcell

electronics

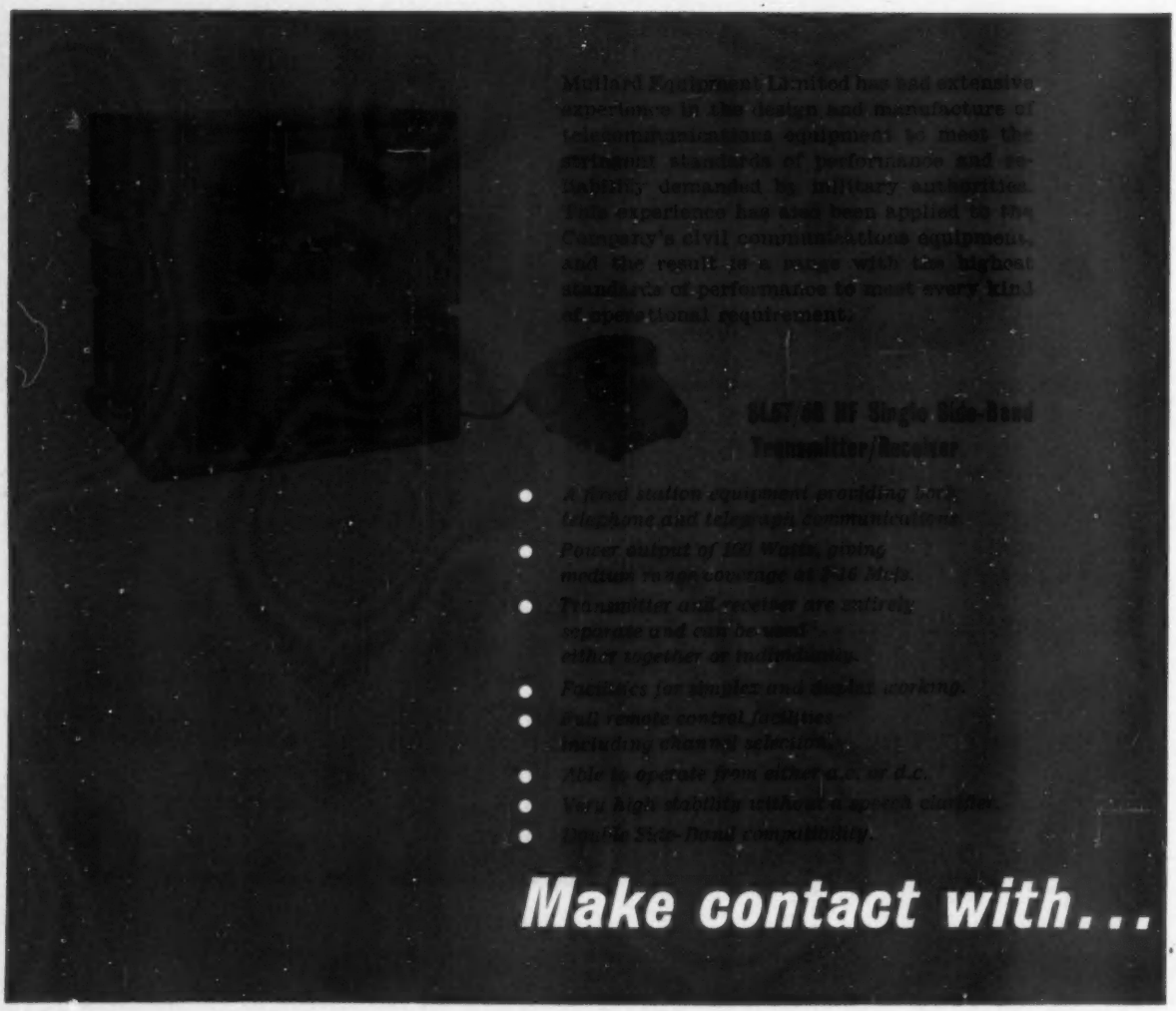
A DIVISION OF MICROCELL LIMITED
Blackwater, Nr. Camberley, Surrey
Telephone: Camberley 3461

The Microcell range of power supplies includes the Type 410—a 1 to 30V. 5 amp. unit, the Type 411—a 500V.—3kV. 10mA Unit and transistorized Sub-Units of up to 5A capacity.
Economy note: Details are now available of the new Microcell Dual-Voltage supplies—offering optimum performance at minimum cost.

PROGRESS THROUGH KNOWLEDGE

EE 40 114 *for further details*

A COMPLETE RANGE OF TELECOMMUNICATIONS EQUIPMENT FOR BOTH CIVIL AND MILITARY APPLICATIONS



Dual Diversity Independent Side-Band Receiver GFR 552

Designed in conjunction with the British Post Office, the GFR552 is capable of receiving independent single and double side-band transmissions over a continuously variable frequency range of 4-30 Mc/s in long distance HF radio links.

Automatic frequency control is incorporated and provision is made for 9 crystal channels and variable bandwidth facility.

The equipment is suitable for use in broadcast-relay applications and can be worked with dual and triple-diversity aerial systems.

Military VHF/FM Transmitter/Receiver C45

In service with the UK Army and fully consistent with NATO standards, the C45 is hermetically sealed and ruggedised to K114.

It is designed for mobile working on 12 or 24V d.c., giving 15W output over the range 23-38 Mc/s, and is available for 100 Kc/s channel spacing (151 channels) or 50 Kc/s channel spacing (301 channels). Operation is very simple and no netting procedure is required. Facilities include; vehicle inter-communication through the harness and also re-broadcasting and remote control up to 1,000 yards on a single pair.

HF Command Transmitter SL56

This is a versatile equipment which can be employed in a variety of applications by the use of alternative drive units such as the C11 or SL63. It is continuously tunable over the range 2-24 Mc/s and, because of unit construction, it is suitable for installing in vehicles from the "Land Rover" upwards. With suitable drive units, the SL56 provides the following outputs:

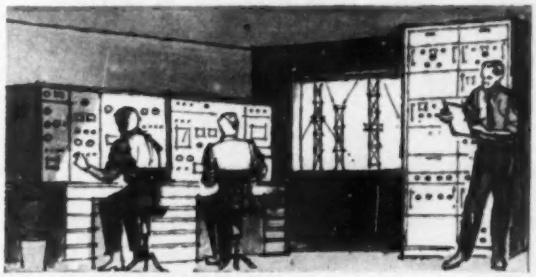
CW ... ... 1 kW FSK ... ... 1 kW

RT ... ... AM–400W, PM–1 kW, SSB–1 kW

The SL56 amplifier units can be supplied in instances where customers already have suitable drive units.

Rural Carrier Telephone System TRC7

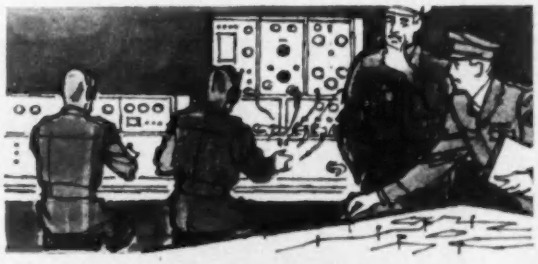
This transistorised carrier telephone gives up to 7 stackable channels; a separate frequency for each subscriber gives complete privacy on a single exchange pair. The flexibility of the system enables it to be arranged to suit almost any requirements of the user. It is simple to install, fully tropicalised and has a low power consumption. A.C. or d.c. power supply units are available, and the choice of relays sets is compatible with all standard exchange systems.

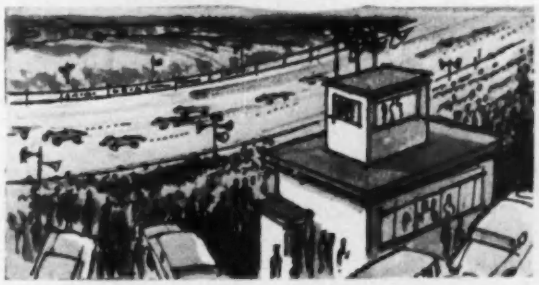


Low Power HF Single Side-Band Radio Telephone SL55

Compact single unit (including a power pack for 12/24V d.c. or 110/200V a.c.) for fixed or mobile working. The transistorised d.c. power pack gives a low consumption when used from batteries.

The SL55 has a frequency range of 2-16 Mc/s, and its frequency stability eliminates the need for a speech clarifier. Provision is made for 4 crystal channels. Remote control can be provided, and the set is also suitable for double side-band and CW telegraphy.





For details of the full range of telecommunications equipment, write to the following address quoting reference No. D/679/12

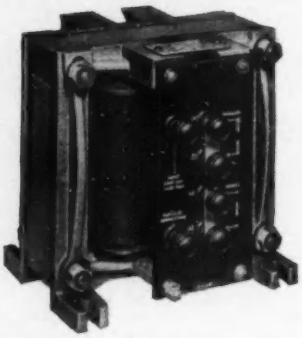
MULLARD EQUIPMENT LIMITED

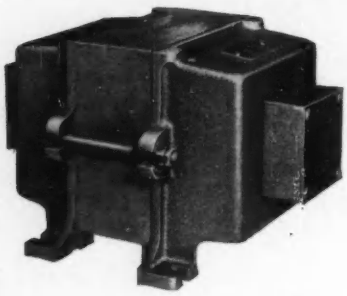
Manor Royal, Crawley, Sussex
Telephone: Crawley 28787

ME679

EE 40 116 *for further details*

ZENITH





RELUCTANCE . . .

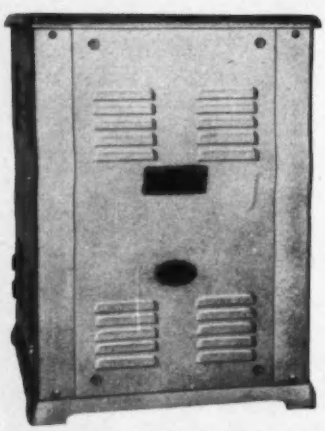
is observed only by our choke designers. It is not evident in our desire to satisfy your request, be it one of design or service. You will find us unfailingly helpful especially when your problem is the "one off" unusual design, which a standard production will not resolve. We take pride in being one of the few today who are anxious to consider such matters.

Transformers & Chokes

Unlike most other ZENITH products, Transformers and Chokes cannot be catalogued. The diversity of windings our customers demand precludes any such literature.

Having arranged the production unit to meet the call for those special single items and short runs, we welcome enquiries from engineers confronted with such a situation.

Single phase and three phase Transformers, both A.N. and O.N., can be supplied within the range 5 VA up to 35 kVA at attractive prices.



Automatic Voltage Regulator

ZENITH Automatic Voltage Regulators incorporating our VARIAC Continuously-Adjustable Transformer are available for single and three phase supplies. The outputs are stabilised at ±1% irrespective of loads within their rating.

There is no measurable wave form distortion under any condition of load and power factor up to the rated capacity, and the sensing device remains insensitive to frequency variation between 45 and 60 cycles.

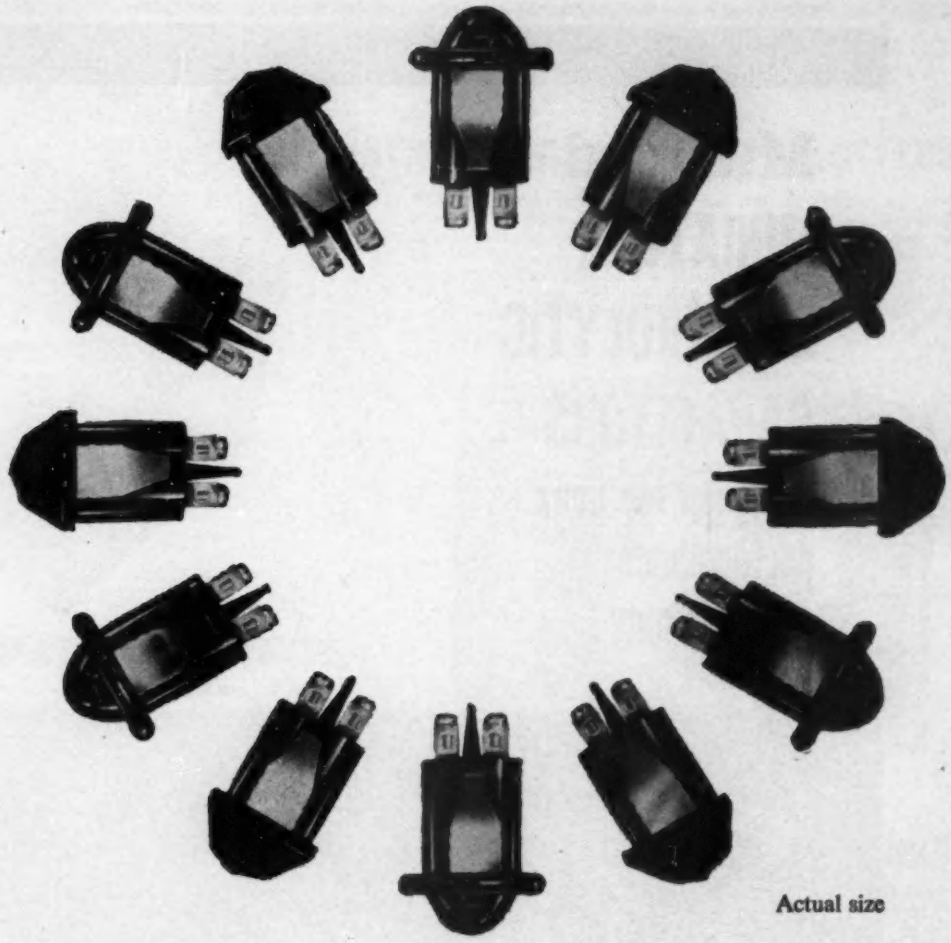
Single phase outputs 6 kVA to 21.25 kVA; three phase outputs 18 kVA to 64.8 kVA.

Catalogue AVR.3 gladly sent on request.

THE ZENITH ELECTRIC COMPANY LIMITED

ZENITH WORKS · VILLIERS ROAD · WILLESDEN GREEN · LONDON N.W.2

Telephone: WILLESDEN 6581/5 Telegrams: "VOLTAOHM, LONDON N.W.2"



Actual size

NEW HEAT-RESISTANT SIGNAL LAMPS FROM THORN

Three signal lamps designed to operate in extremes of both heat and cold . . . invaluable for use in heating equipment (electric cookers, heat treatment plant etc.) as well as in refrigeration plant. These long-life lamps are specially designed with steel spring plates for simple fitting . . . just push them into a close-fitting recess, no retaining nuts or screws. When you have to change them, pull out the old, push home the new. Lamps are available in the two shapes illustrated and in a range of useful colours. Neon or incandescent lamps are built into their plastic holders as a single integral unit.

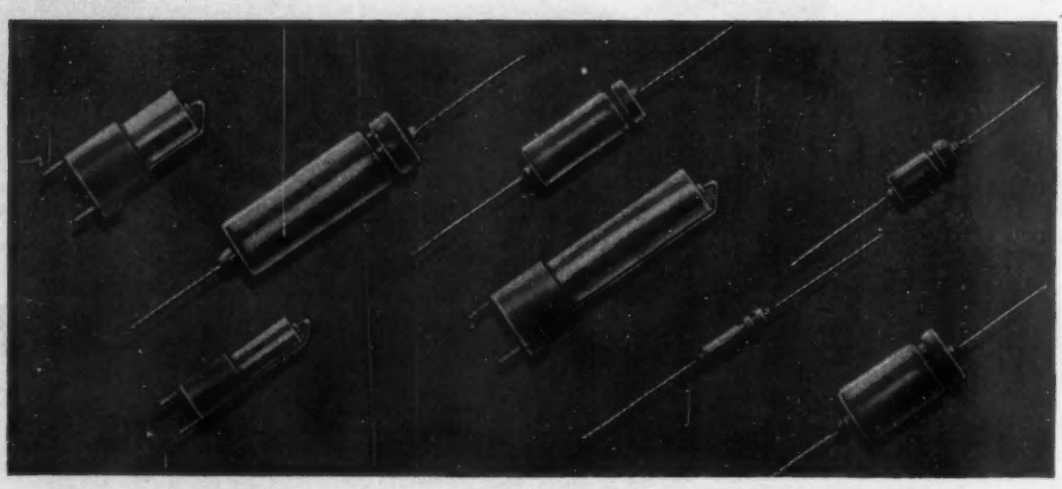
SGF20 Designed to operate in temperatures up to + 125°C.
With incandescent lamp – in red, yellow, clear, opal, green – voltages from 4 to 48.
With neon lamp – in red, yellow, clear, opal, green – voltage ranges 80-130; 160-280; 300-400.
SGF16 Designed to operate in temperatures up to + 70°C. Available with neon lamp only in red, yellow, clear – voltage ranges 90-130; 160-280; 300-400; 450-550.
SGF1717 Designed to operate in temperatures from – 100°C to + 135°C.
With incandescent lamp – in red, yellow, clear, opal, green – voltages from 4 to 24.
With neon lamp – in red, yellow, clear, opal, green – voltage ranges 90-130; 160-280; 300-400.

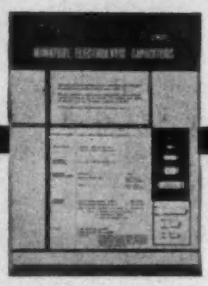
For further details please write to:

THORN ELECTRICAL INDUSTRIES LTD., Special Products Division, Great Cambridge Rd., Enfield, Middlesex. Telephone : ENFIELD 5353

DTV/8

Mullard
MINIATURE ELECTROLYTIC CAPACITORS
designed for peak performance and economy....





Literature and full technical details

are available on request to Mullard House

- High quality
- Comprehensive range
- Small physical size
- High capacitance x voltage product
- Low series resistance
- Close production quality control
- Cost saving

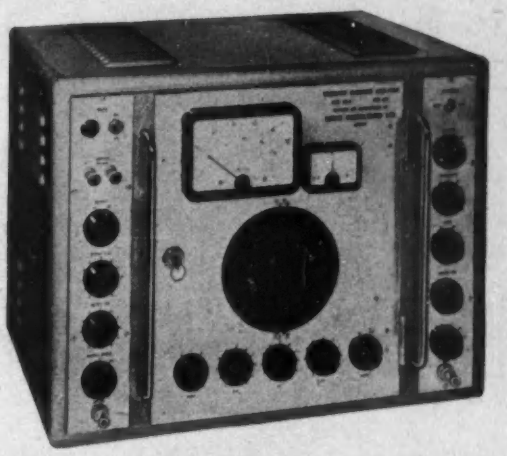
Mullard MULLARD LIMITED · COMPONENT DIVISION · MULLARD HOUSE · TORRINGTON PLACE · LONDON WC1

MC 214

SERVO TEST GEAR

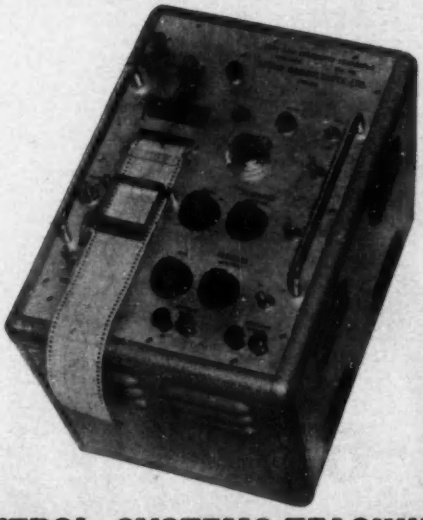
AUTOMATIC NYQUIST DIAGRAM PLOTTERS

The most versatile and quickest way of measuring and plotting of harmonic response diagrams. No additional equipment is necessary for measuring the response of carrier operated servo systems. Mechanical output for coupling to hydraulic and mechanical input systems. Wide frequency range. 30 cm diameter graph paper. High sensitivity models giving full scale deflection at 50mV are available.



TRANSFER FUNCTION ANALYSERS

Direct indication of phase, angle and amplitude. Share with our Automatic Nyquist Diagram Plotters their unique versatility. Extensive frequency range. Mechanical output. DC or modulated carrier output/input.



LOW FREQUENCY GENERATORS

Lowest frequency limit 1 cycle per 3 hours. Instantaneous Start-Stop facility. Can be used as a modulator of carrier within frequency range 50c/s - or 3KC or, as a precision laboratory variable speed drive. Special models, like the one illustrated, are available, providing most comprehensive servo test facilities in minimum space.

CONTROL SYSTEMS TEACHING AIDS

Precision made range of instruments designed for demonstration of performance of servo systems. DC and 400c/s servo amplifiers have been specially designed to give high performance linear response of considerable range. Truly independent three term control (proportional, derivative and integral). Graphic front panels. Modern high performance servo components are used in the compact backlash-free gearboxes.

For full details write to:

SERVO CONSULTANTS LTD

10 BOUVERIE PLACE, LONDON, W.2. PAD. 2811

EE 40 120 for further details

Vidaflex SS 400

the **NEW** extruded silicone elastomer sleeving

flexible from −60° to +250° C
high electric strength
low dielectric losses
better physical properties
improved tear strength
resists oxidation, moisture and corona
competitive prices
non-fading colours
speedy delivery
complies with BS.2848 Type 5 Class 180T
A.I.D. approved

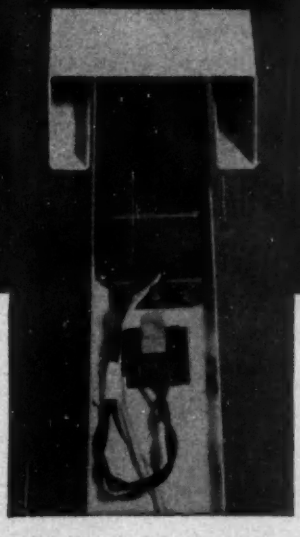
write for descriptive leaflet to

JONES, STROUD & CO. LTD.

manufacturers of Vidaflex insulating materials

Highfield Mills, Canal Street, Long Eaton, Nottingham
Telephone: Long Eaton 4421
London Office: 7-8 Market Place, W.1
Telephone: LANgham 9488

FALKS "Truncolite" for Large-scale Industrial Lighting



FALKS "Truncolite" provides you with an infinitely extensible and widely adaptable base for fluorescent lighting schemes using continuous trunking. "Truncolite" is ideal for all large-scale industrial lighting applications.

FALKS, the long established lighting specialists, designers and manufacturers of all types of fittings. Lighting Engineering Services freely available.

We welcome your inquiries

FALKS

FALK, STADELMANN & CO. LTD.

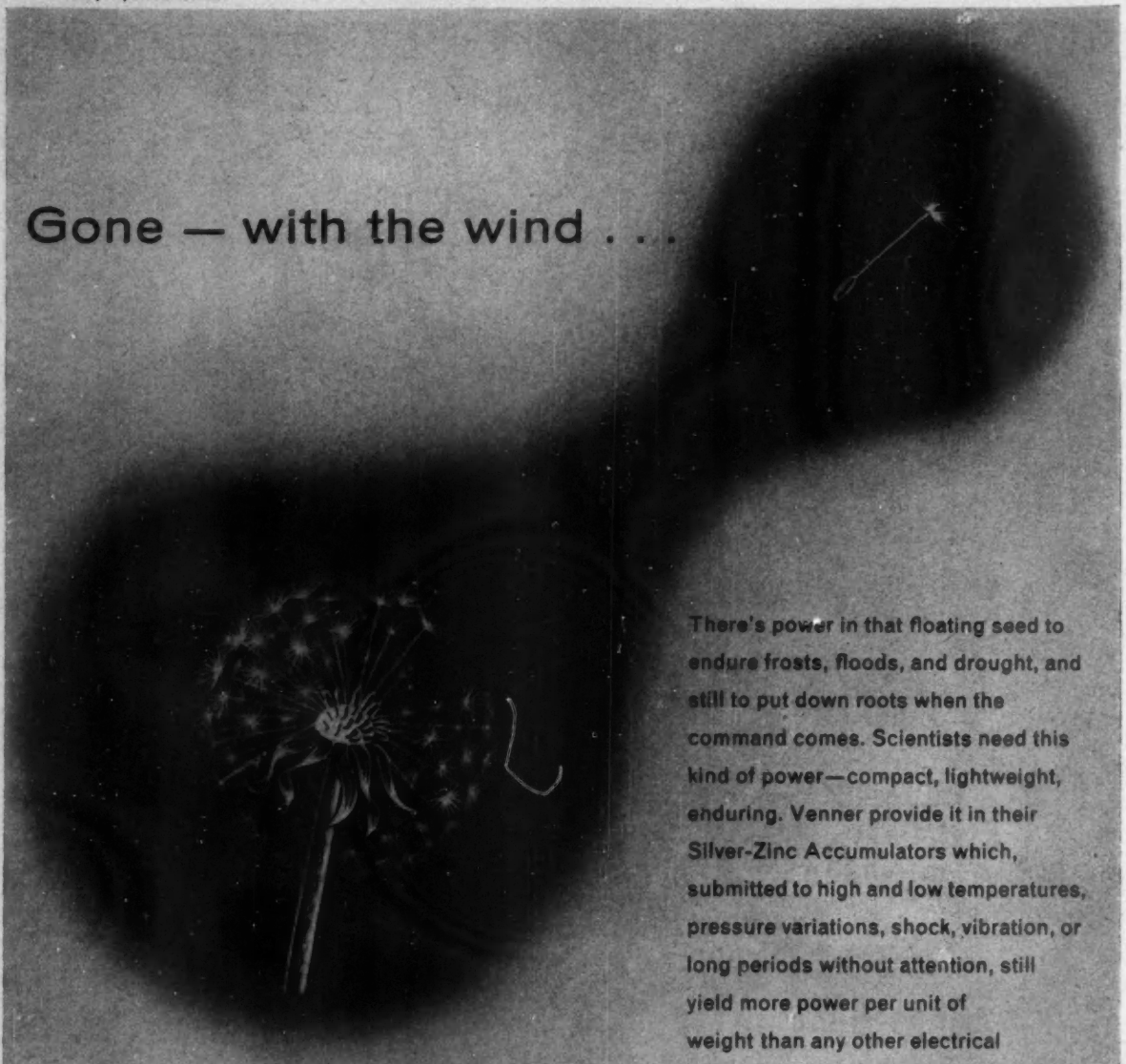
THERE'S A MODERN FALKS FITTING FOR EVERY PURPOSE

51 FARRINGDON ROAD, LONDON, E.C.1. Tel: HOLborn 7864. London Showrooms: 28/22 MOUNT STREET, PARK LANE, W.1. Tel: MAYfair 9671/2

AP 134

EE 40 122 *for further details*

Gone — with the wind . . .



There's power in that floating seed to endure frosts, floods, and drought, and still to put down roots when the command comes. Scientists need this kind of power—compact, lightweight, enduring. Venner provide it in their Silver-Zinc Accumulators which, submitted to high and low temperatures, pressure variations, shock, vibration, or long periods without attention, still yield more power per unit of weight than any other electrical storage system.

VENNER SILVER-ZINC ACCUMULATORS

VENNER SILVER-ZINC ACCUMULATORS provide lightweight power for satellites, guided missiles, airborne equipment of all kinds, telemetering systems, etc.

Send for full technical details

Venner Accumulators Limited

KINGSTON BY-PASS, NEW MALDEN, SURREY. MALDEN 2442

A member of the Venner Group of Companies

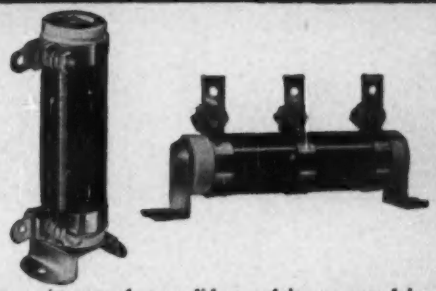
EE 40 123 *for further details*

expamet | cressall

Resistors · Rheostats Control Units and Heaters

COMPONENTS AND ASSEMBLIES FOR LOADS FROM 4 WATTS TO OVER 20,000 KILOWATTS

Vitreous enamelled resistors wire-wound or corrugated edge-wound tape on ceramic core. Withstand severe vibration and thermal shock. 6 to 220 watts rating.



Open wire-wound on solid porcelain or porcelain tubes. With or without tapping bands. 24 to 220 watts, 1.1 ohms to 28,400 ohms.

Wire-wound on vitreous enamelled steel tubes. Available as either open or protected models. Single or double tube models up to 14,500 ohms.

Bright annealed resistance wire or tape on best quality mica. Foot mounted or protected units available. Banked assemblies to order.

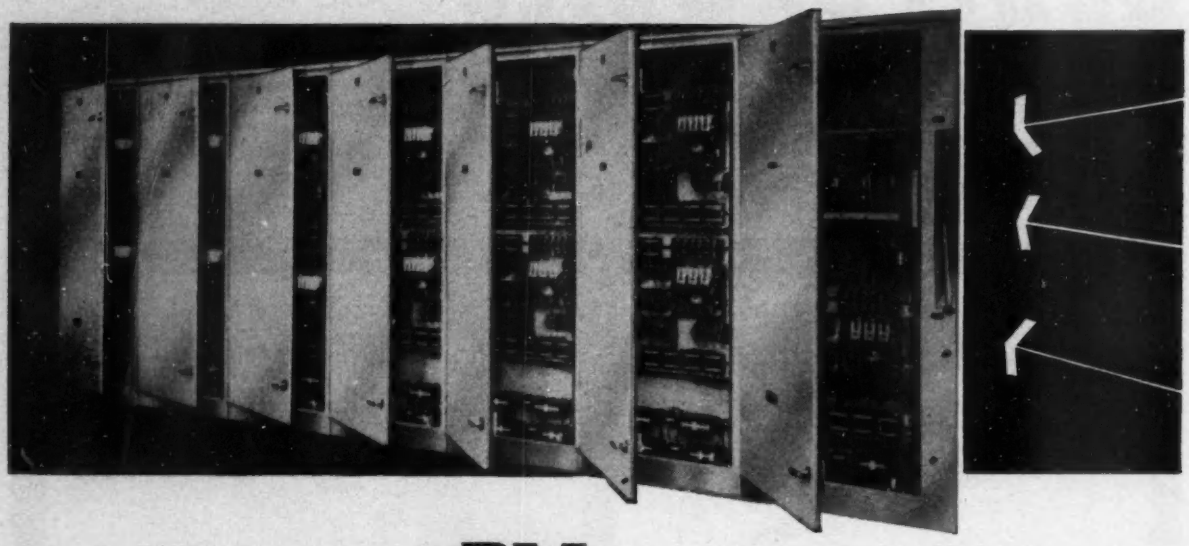
expamet | cressall

The Electrical Division of the Expanded Metal Company Limited

THE CRESSALL MANUFACTURING COMPANY LTD · 59 CHESTON ROAD · BIRMINGHAM 7 · TEL: EAST 3571

EE 40 124 *for further details*

SPECIAL PURPOSE CONTROL PANELS



BY DONOVAN

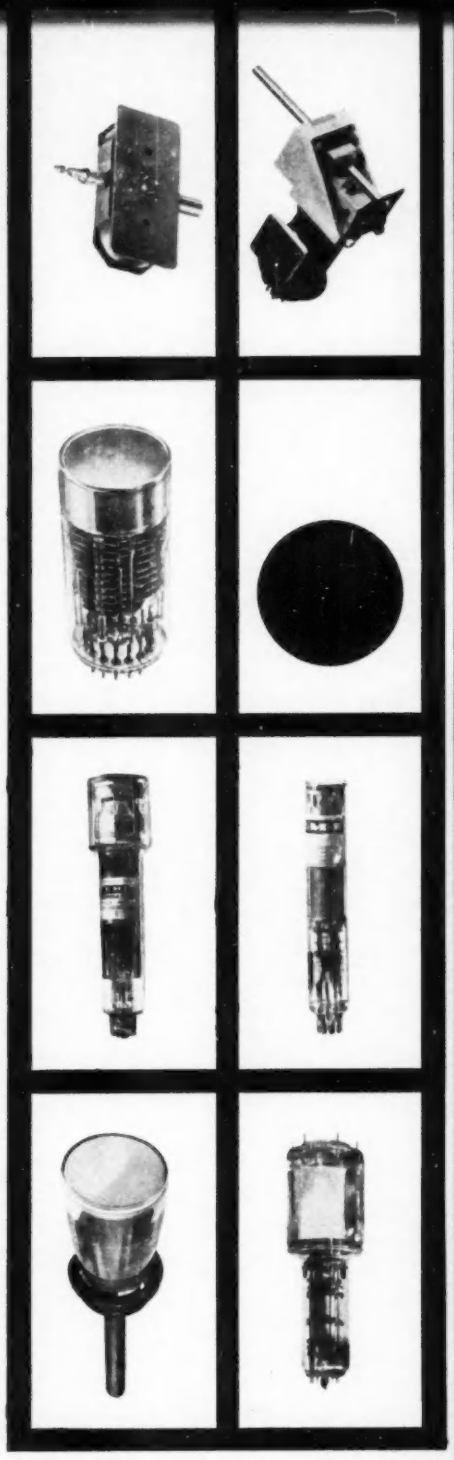
This SPECIAL 7-door section of a 13-door Transfer Machine control panel may look like any other switchboard BUT—STANDARD-PROVEN Donovan Contactors, Relays, Overloads, Isolators, and accessories, are used throughout and in addition the panels are plug-in for quick replacement and maintenance—a valuable feature only offered by Donovan.

Senior Executives and Buyers desiring a comprehensive list of Donovan standard and special products are invited to apply for copies of the Donovan Catalogue.

THE DONOVAN ELECTRICAL CO. LTD.
78-82 GRANVILLE STREET, BIRMINGHAM, 1

London Depot: 148-151 YORK WAY, N.7. **Glasgow Depot: 22 PITT STREET, C.2**

Sales Engineers available in LONDON, BIRMINGHAM, MANCHESTER, GLASGOW, BELFAST, BOURNEMOUTH



EMI Electron Tubes

EMI

EMI ELECTRONICS LTD

VALVE DIVISION . HAYES . MIDDX.
Telephone: HAYes 3888 Ext. 2165

EMI offers a very wide range of special tubes

These are brief details of some of the EMI special tubes. For further information please send the reply-paid card to EMI.

PHOTOMULTIPLIER TUBES AND PHOTOCONDUCTIVE DEVICES

EMI is the largest producer of photomultiplier tubes in Europe and these tubes are outstanding for very low values of dark current obtainable, with high gain, photosensitivity and stability of operation. They are supplied with various types of photo cathode for specific applications. 'S' cathode tubes for example are particularly suitable for carbon 14 and tritium counting. Solid state radiation detectors are also available for specialised applications.

MICROWAVE TUBES

EMI Reflex Klystrons include a wide range of plug-in klystrons and tuneable cavities giving continuous coverage from 3,000 to 12,000 M/cs. ('S' to 'X' band); a new, advanced design 'J' band tube is now in the late stages of development. Integral cavity types covering 'K', 'Q' and 'J' band, have improved tuner for good frequency stability and freedom from microphony. A 4 cavity, water cooled Klystron with a gain of 50 dB and capable of handling peak powers in 'S' band of 100 kW is also available.

Magnetrons. EMI produces a range of packaged magnetrons for high power pulse operation, designed for use in 'J', 'Q' and 'O' bands.

CAMERA TUBES

EMI camera tubes include the following:—

4½ inch image orthicons both standard and high sensitivity tubes.

C.P.S. orthicon—the ideal tube for systems conversion. Linear transfer characteristic and absolute black level.

1 inch vidicons of many types including tubes for TV colour cameras, high sensitivity tubes, infra-red or ultra-violet sensitive tubes and a long lag tube suitable for radar/TV conversion or for recording single strobe flash pictures. Recent addition to the range is a special ruggedised tube.

CATHODE RAY TUBES AND STORAGE TUBES

The EMI range of high quality, high precision cathode ray tubes includes all types of radar tubes from 2 inch airborne radar tubes giving extremely high definition to 21 inch metal coned tubes. Oscilloscope tubes include those capable of recording single transients with a rise time of 1 milli-micro second. Film scanners and TV monitor tubes are also available. A barrier grid storage tube which is finding wide application in medical and other fields is a new addition to the range.

Postage will be paid by Licensee

No postage stamp necessary if posted in Great Britain or Northern Ireland

BUSINESS REPLY CARD
Licence No. SOX 64

VALVE DIVISION · DEPT. EC5
EMI ELECTRONICS LTD
HAYES · MIDDLESEX

E.E. 177A

idm ELECTRONICS LTD

SLIP RINGS

BRUSHES

COMMUTATORS

PRECISION

ROTARY SWITCHES

FROM

30" diameter Slip Ring. Split for ease of assembly. Electrodeposited fine silver rings for lowest noise levels (strain gauge application)

I.D.M. ELECTRONICS offer a complete range of precision sliding contacts.

Rings may be of electrodeposited 24 carat Gold or electrodeposited Fine Silver.

This results in:

- Unique one piece unitized construction for strength.
- Minimum diameters. Minimum torque.
- No accumulated tolerances.
- 24 carat Gold gives complete freedom from tarnish.
- Lowest electrical noise levels.

* Electro Tec. Corp. Patent No. 748480

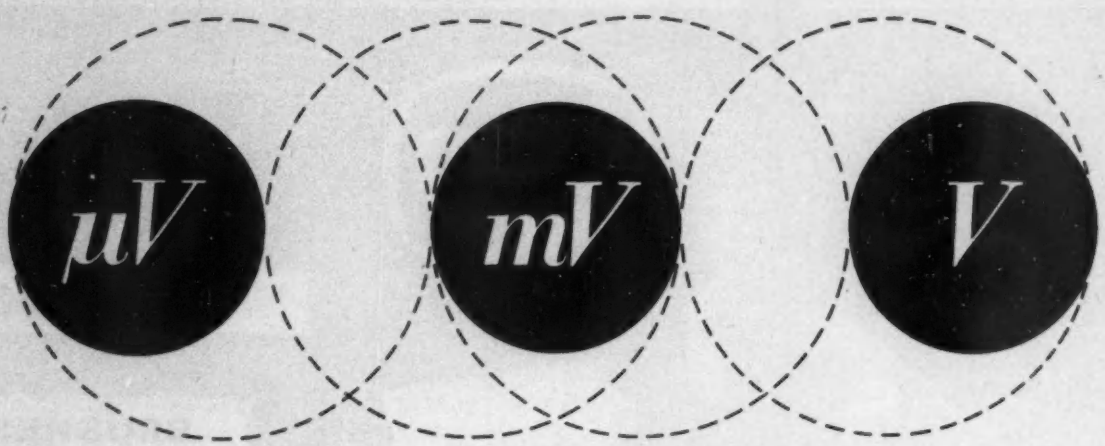
TO

IDM ELECTRONICS LTD.

Whitley Kiln · Basingstoke Road · Reading

Telephone: Reading 82557/8

EE 40 126 *for further details*



electronic millivoltmeters

internal calibration

It should be noted that all Philips electronic voltmeters contain calibration standards which enable the user easily and rapidly to check, and, if necessary, to re-calibrate his voltmeter at any time without the use of additional instruments.

VHF Voltmeter, type GM 6025

Frequency range: 0.1 Mc/s - 800 Mc/s
flat from 1 Mc/s - 300 Mc/s
−1 dB at 0.1 Mc/s
+1 dB at 800 Mc/s

Measuring range: 10 mV (f.s.d.) - 10 V divided into 7 ranges in a 1-3-10 sequence

Overall accuracy: < 5% with respect to full scale

Input resistance: 65 kΩ at 1 Mc/s ; 50 kΩ at 100 Mc/s ; 35 kΩ at 200 Mc/s

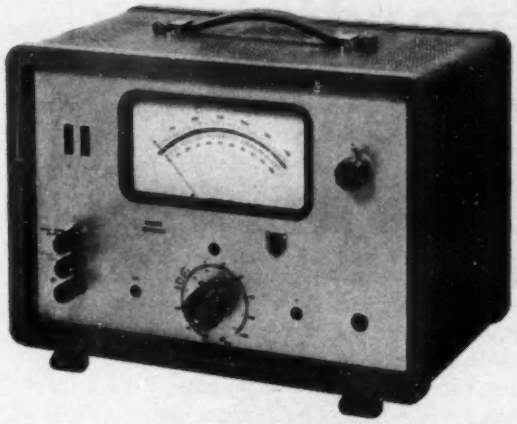
Input capacitance: 1 μμF

Replacement of the probe crystal:
the probe crystal can be easily replaced and the instrument rapidly re-calibrated by the user

For measurements on 50Ω -coaxial lines the T-connector, type GM 6050T, can be ordered

PHILIPS *electronic measuring*

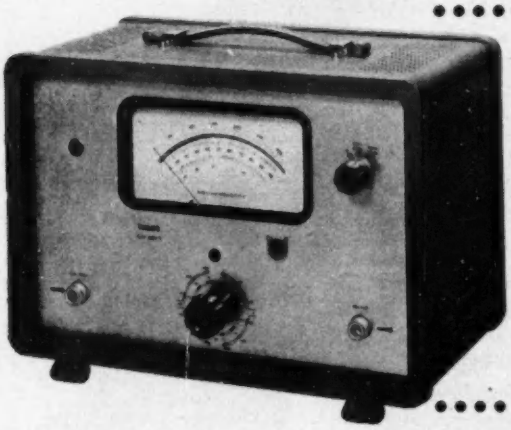
Sold and serviced by Philips Organizations all over the world.
Sole Distributors in the U.K.: **Research & Control Instruments Ltd., 207 King's Cross Road, London W.C. 1**
Overseas enquiries please, to the manufacturers, N.V. Philips, EMA-Department, Eindhoven, the Netherlands.



DC Microvoltmeter, type GM 6020

	input I	input II
Measuring range:	100 μV (f.s.d.) – 10 V in 11 steps	10 mV (f.s.d.) – 1000 V in 11 steps
Input impedance:	1 MΩ (± 1.5%) in parallel with 20 μμF	100 MΩ (± 1.5%) in parallel with 10 μμF
Overall accuracy:	with respect to full scale ± 3%	
Pre-deflection:	< 5 μV	
Drift:	1 μV per hour after 1 hour of warming-up	

Automatic polarity indication
DC currents may be measured directly from 100 μμA (f.s.d.) up to 10 μA



L F Millivoltmeter, type GM 6012

Frequency range:	2 c/s - 1 Mc/s
Measuring range:	1 mV (f.s.d.) - 300 V in 12 steps
dB scale:	−80 dB up to +52 dB (0 dB = 1 mW into 600 Ω)
Input impedance:	4 M Ω in parallel with 20 μμF (up to 3 V); 10 M Ω in parallel with 10 μμF (in the other ranges)
Overall accuracy:	with respect to full scale ± 2.5%, 5 c/s - 100 kc/s ± 5%, 2 c/s - 1 Mc/s
Pre-deflection:	< 100 μV

HF Millivoltmeter, type GM 6014

	without pre-attenuator	with pre-attenuator
Frequency range:	1 kc/s-30 Mc/s	10 kc/s-30 Mc/s
Measuring range:	1 mV (f.s.d.) - 300 mV in 6 steps	100 mV (f.s.d.) - 30 V in 6 steps
dB scale:	−80 dB up to -8 dB	−40 dB up to +32dB
Damping at 10 kc/s:	1 MΩ	50 MΩ
1 Mc/s:	700 k Ω	10 MΩ
30 Mc/s:	50 k Ω	2 MΩ
Input capacitance:	7 μμF	2 μμF
Pre-deflection:	compensated by electrical zero setting	

Variations of the frequency characteristic:
< 5% over the whole range, with respect to the response at the frequency of the calibration voltages

Overall accuracy: ± 3% with respect to full-scale and with reference to the frequency characteristic

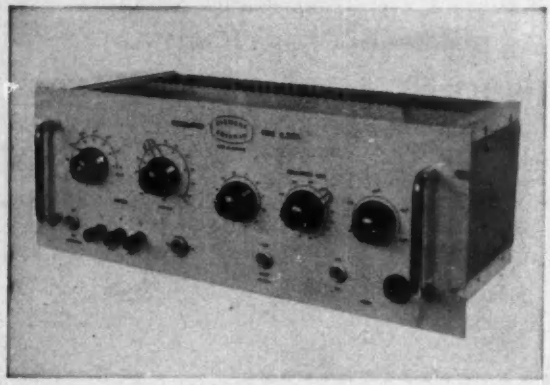
instruments: quality ***tools*** for industry and research

PHILIPS

EE 40 128 *for further details*

Oscillographic recording and testing equipment from Siemens Ediswan

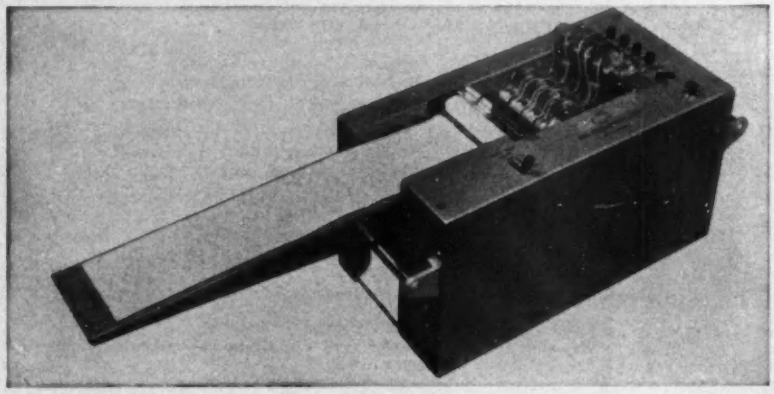
If your work involves the study of fluctuating or intermittent phenomena, you should know more about these instruments.
The versatile High Speed Pen Recorder unit can be supplied singly or grouped in multiples of four up to a maximum of 16 channels and suitable amplifiers having a sensitivity of 1μV/mm a.c. or 10 mV/mm d.c. can also be supplied. These combinations are already making permanent economical records in industrial, physiological and physical research.



LOW FREQUENCY OSCILLATOR TYPE R.2125

The Low Frequency Oscillator is a general purpose R.C. instrument designed for testing, calibrating and setting up amplifiers, recorders, and low frequency wave analysers.

Frequency Range	1 c/s to 132 Kc/s
Frequency accuracy	2%
Output	Balanced push pull, 50 volts p.p. maximum on open circuit.
Attenuator	5 x 20 dB steps plus 0—20 dB continuously variable.
Output Impedance	600Ω—0—600Ω

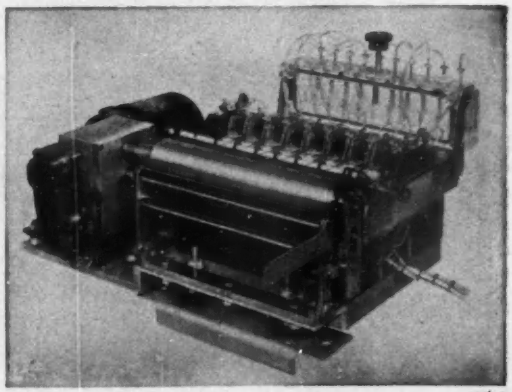


PORTABLE RECORDER TYPE EPR

The Siemens Edison Swan pen oscillograph is a portable 1 to 4 channel, high speed, direct ink writing, recorder.
The pen motor coil is 1450 ohms centre tapped.
Frequency response within 10% from 0–70 c.p.s.
Pen motors can be supplied with coil resistances of 230 ohms for use with transistors.
Maximum deflection of pen tip 4 cms peak to peak.
An electrical time and event marker is provided, writing on the lower edge of the paper.
The 4″ wide paper is driven by a rubber covered capstan roller and speeds of 0·75 cms/sec. to 12 cms/sec. can be obtained.

8 CHANNEL PEN RECORDER UNIT

The pen motors incorporated in this unit are identical to those used in the 4 channel pen oscillograph.
The unit includes 8 pen motors fitted into a magnet block, two time markers, ink system and paper drive mechanism.
Three speeds of 1·5, 3 and 6 cms/sec. are available.
The unit is offered as shown in the photograph and is intended for incorporation into the users own equipment.
A 16 channel version of the above unit is also available.



AEI

Associated Electrical Industries Ltd
Radio and Electronic Components Division
PD17, 155 Charing Cross Road, London, WC2
Tel: GERrard 9797.

17/19

EE 40 129 *for further details*

Cost conscious electronic engineers certainly have their share of horse sense, and appreciate that the best way of doing things is not necessarily the most expensive.

The latest additions to our range of trigger tubes is a case in point. For many applications their performance is better than other active devices used in modern circuits, and certainly overall costs can be kept to a minimum. It stands to reason—there is no need for surge protection circuits, long life is assured by the use of pure molybdenum cathodes, and they will operate at mains voltage. Other valuable features of these tubes include the visual indication of current flow and the stability of characteristics under variable temperature conditions.

It will pay you to look into the possibilities of Ericsson Trigger Tubes.

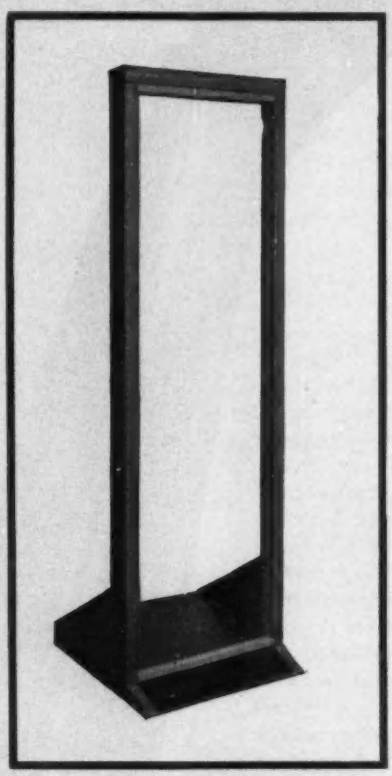
For more details
please write to:
Ericsson Telephones Ltd.
Tube Division
Technical Services Department
Beeston, Nottingham.

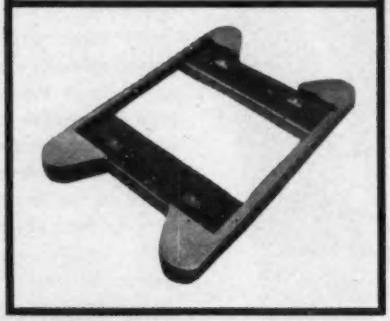
ERICSSON

ERICSSON TELEPHONES LTD · HEAD OFFICE · 22 LINCOLN'S INN FIELDS · LONDON WC2

EE 40 130 *for further details*

NEW!





additions to the IMRAK international series

Send today for full details of these latest additions to the range of International Imraks ; they include :

NEW Open Imrak series, providing an economical panel framework when it is not necessary for the equipment to be enclosed. Available in two widths and four heights.

NEW Mobile bases designed not only for their practicability but also to match the attractive appearance of the raks in this series. Available in four sizes to suit the four basic rak plan sizes.

NEW Extension plinths to provide greater stability particularly when withdrawing heavily loaded chassis or if the equipment tends to make the rak top heavy. Shown here fitted to the Open Imrak but suitable for all raks in this series. Also, as again shown on the Open Imrak, a new range of Filler Plates for blanking off the base in any Imrak.

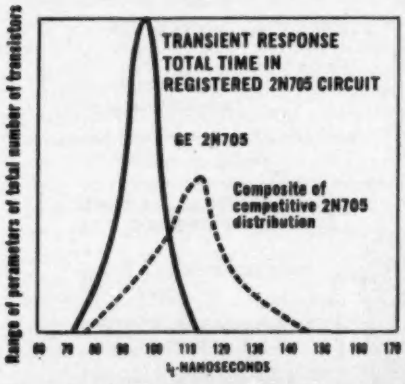
ALFRED IMHOF LIMITED Dept. F.12.
Ashley Works Cowley Mill Road Uxbridge Middlesex England
Telephone Uxbridge 37123 Telex 24177 Telegrams Imcase-Uxbridge-Telex

IMHOFS AGENTS OVERSEAS
Algeria: E.G.E.E., Paris (19)
Australia: Aladdin Industries (Pty) Ltd, Stanmore NSW
Belgium: Rogelec, Ghent
Cyprus: L. Piandjian, Nicosia
Denmark: Tage Schouboe, Copenhagen N
France: E.G.E.E., Paris (19)
Germany: Elek. Dusseldorf
Holland: J. Th. van Reijsen, Delft
Italy: Stuart Culley, Milan
Mexico: Aluminio Arquitectonico S.A., Mexico D.F.
Morocco: E.G.E.E., Paris (19)
New Zealand: Imarex (1960) Ltd Auckland C3
Nicaragua: Talleres Metalureqicos Nanaqua
Norway: Birger Christensen, Oslo
Portugal: Projectos e Construções Lda, Lisbon
South Africa: Switchcraft (Pty) Limited, Johannesburg
Sweden: Electronlund AB, Malmo I
Switzerland: Walter Blum, Zurich 2/39
Tunisia: E.G.E.E., Paris (19)
U.S.A.: Bud Radio Inc, Cleveland 3, Ohio
British Guiana: Davsons Caribbean Agencies Ltd, Georgetown

*Nuclear power report from General Electric Company, U.S.A.**

HIGH-SPEED GERMANIUM MESA OFFERS 600 MCS GAIN-BANDWIDTH PRODUCT

Its high speed and extended life make the General Electric 2N705 germanium PNP triode mesa transistor ideal for very high-speed industrial switching applications. Speed is assured by a gain-bandwidth product of 600 mcs. As for long life, tests demonstrate up to 7,000 hours of trouble-free operation. The G-E 2N705 also meets the mechanical and environmental requirements of the U. S. Military. □ For low-cost computer applications, General Electric 2N711 may be specified. And for other lower-voltage, lower-cost applications, there are types 2N710, 2N725, and 2N1646. For complete technical details, contact your G. E. representative or write to: International General Electric Co. of New York, Ltd., Lincoln House, 296-302 High Holborn, London W. C. 1, England.

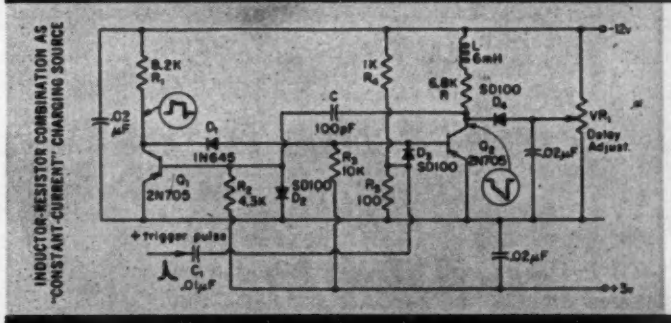


◀ This comparison illustrates the speed of the General Electric 2N705. Note the narrow spread as well as the decrease in total switching time.

RATINGS AND CHARACTERISTICS (25° C)

	2N705		2N711		
DISSIPATION					
Total Dissipation (25°C Ambient)*	150		150		mw
	Min.	Max.	Min.	Max.	
STATIC CHARACTERISTICS					
Collector Cutoff Current (V_{CB} = −5V)		−3		−3	μa
VOLTAGE CHARACTERISTICS					
Collector to Emitter Breakdown (I_C = −100 μa)	−15		−12		volts
Collector to Emitter Saturation 2N705 (I_B = −0.4 ma., I_C = −10 ma)		−0.3			
2N711 (I_B = −0.5 ma., I_C = −10 ma)				−0.5	volts
HIGH FREQUENCY CHARACTERISTICS					
Gain-Bandwidth Product (I_E = 10 ma, V_{CE} = −5V)	600**		600**		mcs

* Derate 2 mw/°C increase in case temperature above 25° C. ** Typical



You may wish to use fast transistors like the G-E 2N705 germanium mesa in designing accurate delay generators. The circuit shown maintains an average accuracy of 1 per cent from −20° C. through +80° C. With simple screwdriver manipulation, it is continually adjustable from 30 nanoseconds through 1 microsecond.

Progress Is Our Most Important Product

GENERAL ELECTRIC

—U.S.A.—

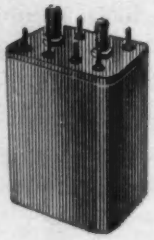
**General Electric Company, U.S.A., is not connected with the British company of the same name.*

EE 40 132 *for further details*

Plessey

relays

MINIATURE TYPE CA



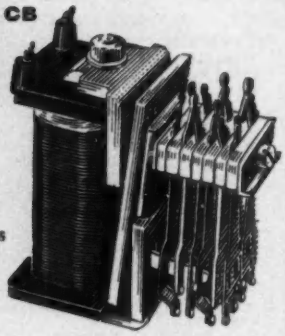
Fully Type Approved to RCS 165 and 166.

Light and medium duty types have two changeover contacts.

Heavy duty types single make or break.

Available sealed, or unsealed with dustcover.

MINIATURE TYPE CB



Based on Type CA with heavier magnetic circuit.

All versions fully Type Approved.

Available with up to twelve springs.

Twinned platinum contacts on light duty versions.

Available sealed, or unsealed with dustcover.

MINIATURE TYPE CC

Meets RCS 165 and MIL-R-5757 specifications.

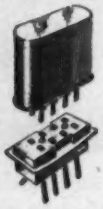
Based on Type CA magnetic circuit, providing up to four light or medium-duty contact sets.

Available sealed, or unsealed with dustcover.

Printed circuit versions available.

Contact loadings up to 10A d.c., non-inductive, can be arranged for Types CA, CB, and CC.

SUB-MINIATURE TYPE CE



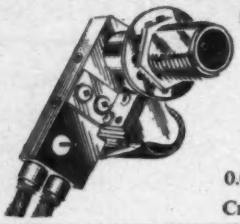
Occupies less than ¼ square inch of chassis area.

Two changeover contacts rated 0.25A at 28 V d.c.

Insulation proof against 500 V a.c., r.m.s. between coil and contact stack.

−55°C to +100°C operational temperature range.

PANEL SEAL COAXIAL TYPE CX



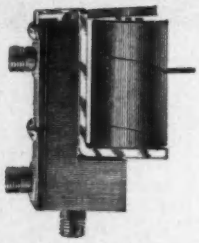
Meets Spec. DEF 5000 for materials and finish.

Single pole changeover, rated at 30 W RF in 50 ohms.

0.05 dB max. loss up to 400 Mc/s.

Crosstalk better than 40 dB down.

MINIATURE COAXIAL TYPE CY



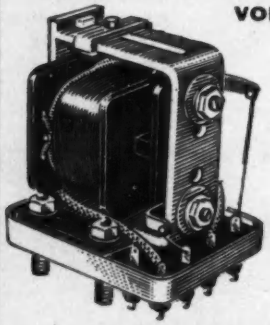
Single pole changeover, rated at 1 W RF in 50 ohms.

0.05 dB max. loss up to approx. 100 Mc/s.

−55°C to +100°C operational temperature range.

Better than 100 megohms insulation resistance at 250 V d.c.

VOLTAGE REGULATING TYPE XC 269



Fully Approved to S.R.D.E. Spec. 166/1.

Temperature compensated in range −40°C to +85°C.

Available for 6, 12 or 24 V operation.

Typical changeover voltage differential 1 V in 24 V.

meet the latest electronic requirements

Plessey

THE PLESSEY COMPANY LIMITED
(Relays and Control Systems Unit)
Eddes House · Eastern Avenue West · Romford · Essex
Telephone: Seven Kings 6050
Overseas Sales Organisation: Plessey International Limited · Ilford · Essex
Telephone: Ilford 3040

RCS1a

ELECTRONIC ENGINEERING

VOL. 33 No. 406

DECEMBER 1961

Commentary

TWO of the more influential professional engineering institutions on the other side of the Atlantic have recently announced that they are setting up committees to investigate the possibilities of moving 'actively toward the consolidation of the activities and organization by consolidation or otherwise, provided that the legal and operational problems incident to such consolidation can be satisfactorily resolved'.

The two institutions concerned are so well known and have established such a world wide reputation that they scarcely need any introduction.

They are of course the American Institute of Electrical Engineers which was founded in 1884 and now has a membership of about 70 000 mostly in the United States and Canada, and the Institute of Radio Engineers, founded in 1912 with an extraordinarily high membership of 91 000 scattered throughout the world.

For a number of years the two Institutes have collaborated very closely where matters of common interest have been involved and they have now reached the conclusion that—to quote their own words—'the advancement of the theory and practice of electrical and radio engineering and the educational and scientific objectives of both Institutes may be better served by merger or consolidation into one organization in which all present members would be included, and in which they would enjoy the same rights and privileges now conferred on them by their separate organizations.

The two committees have now been instructed to submit their report to the two Institutes not later than February next for their approval 'with a view to submission to a vote of the memberships of the two Institutes and consummation, if so approved, by 1 January, 1963'.

Amalgamation of learned and professional societies with common interests is of course no new phenomenon, as witness the recent joining together in this country of the Institute of Physics and the Physical Society, but the present proposal is one of the largest of its kind, and if adopted will result in the formation of probably the most powerful and influential engineering institution in the world with a total membership of over 150 000.

Time was perhaps when 'heavy' and 'light' electrical engineering were separate and distinct branches of science with little or nothing in common. Once upon a time there certainly was the 'heavy' electrical engineer engaged in what might be broadly described as the generation and distribution of electrical power and the 'light' electrical engineer whose interests did not extend beyond the field of radio and communications, and both types of engineer were only vaguely aware of the others' activities.

But in the meantime the new science of electronics has literally burst upon us and the impact it has made on electrical engineering proper has been such that it is difficult to visualize a competent electrical engineer of today without a background of electronics. Equally, with the growth of industrial electronics in particular the electronic engineer finds he has much to learn from the older branch.

The progress therefore of the proposed amalgamation of the two American Institutes will be watched with interest and one is naturally led to speculate on whether a similar merger between the corresponding Institutions in this country would be either desirable or advantageous.

Our Institution of Electrical Engineers was founded originally as the Society of Telegraph Engineers but for several decades it has been a predominantly 'heavy' electrical engineering institution and in the past the 'light current' or electronic engineer may not always have felt that the Institution was his proper home or that the title 'chartered electrical engineer' correctly described his status.

But the Institution has kept pace with the times and has provided an active Electronics and Communications Section, which has grown to be the largest of the specialized sections both in actual membership and in the number of papers presented.

And only recently, within the last month or so, the Council has advanced still further by replacing the Specialized Sections by three Divisional Structures to be named Electronics, Power, and Science and General, each Division to work through about ten relatively specialized Professional Groups.

The thirty groups so formed will then cover the whole range of electrical engineering and their number and coverage can be so modified to cope with any change in emphasis in the technological scene, and new aspects of research and development covered by the formation of new Professional Groups.

This is the arrangement that has worked successfully for a number of years in the American Institute of Radio Engineers and there is no reason to suppose that it will not work equally well here.

It would seem that the Institution has maintained a more vigorous electronics section than its American counterpart and has been able to contain a wider range of electrical engineering within its fold and for this reason alone amalgamation would appear unnecessary.

The other institution possibly concerned with amalgamation is of course the British Institution of Radio Engineers whose professional status has now been recognized by the granting of the Royal Charter. It has always been, as its name implies, the institution of the radio engineer but it too has widened its range of activities from radio engineering as originally conceived to cover the whole range of electronics in all its diversifications and it can continue without detriment to interest itself in matters solely radio and electronic.

An Audio Frequency Phase Modulator Using Pulse Techniques

By W. D. Humpage*, B.Sc.

The design of a modulator is discussed, in which the phase of a 1·592kc/s sine wave carrier may be varied in conformity with a modulating voltage. The range of carrier phase-shift is 450°, and the departure from linearity of phase-shift, as a function of the magnitude of a modulation-input, is less than 1 per cent. This linearity is maintained over the total range of carrier phase-shift, and for modulation-frequencies within the band 0 to 10c/s.

(Voir page 830 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 837)

THE fact that a carrier phase-shift may be regarded as a time-delay in the carrier waveform was realized many years ago. One of the earliest recorded phase modulator designs using this basic approach appears to be due to Gordon[1]. In this device, the all-important operation of delaying the carrier waveform in conformity with a modulation-input is effected in a cathode-coupled multivibrator. Other work has been carried out at appreciably lower carrier frequencies than used by Gordon; by Van Ness and Peterson[2] and by Corless and Aldred[3]. The latter two units employ a screen-coupled Phantastron as the delay stage.

In the modulator to be described, the important waveform manipulations of frequency division, linear delay, square wave generation, square wave inversion, and pulsed sine wave generation, are all achieved in cathode-coupled stages.

Description of the Modulator

A block schematic of the modulator is shown in Fig. 1, together with the circuit waveforms. A rectangular waveform is first shaped from the sine wave carrier. The repetition frequency of the positive-going edges of this waveform is one-half of the carrier frequency. Pulses derived from these positive-going edges are used to trigger a linear delay circuit which produces an output waveform whose width is a linear function of the modulation-input. Pulses formed from the delayed waveform are then used to synchronize a square wave generator.

The sinusoidal carrier is finally restored by a pulsed sine wave generator, the drives to which are balanced paraphase square waves at one-half of the carrier frequency. It is necessary to add two outputs from the sine wave generator; this is achieved in a 'virtual earth' adder stage.

The waveform diagrams demonstrate that an increasing time delay produces an increasing phase-shift between the constant frequency sine wave input and the modulator output.

The principal items in the specification for the phase modulator are as follows:

(a) Total range of carrier phase-shift:	400°
(b) Departure from the linearity with which a modulating voltage controls the carrier phase-shift:	± 2 per cent
(c) Modulation-frequency range over which this linearity is maintained:	0 to 5c/s

THE CATHODE-COUPLED MULTIVIBRATOR

The important waveform manipulations in the modulator are carried out in circuits of the type[4,5,6] shown in Fig. 2. This class of monostable circuit has been widely used in waveform work.

The typical arrangement, shown in Fig. 2, with $e_2 > e_1$ has a stable state with V_2 conducting, V_1 cut-off. On

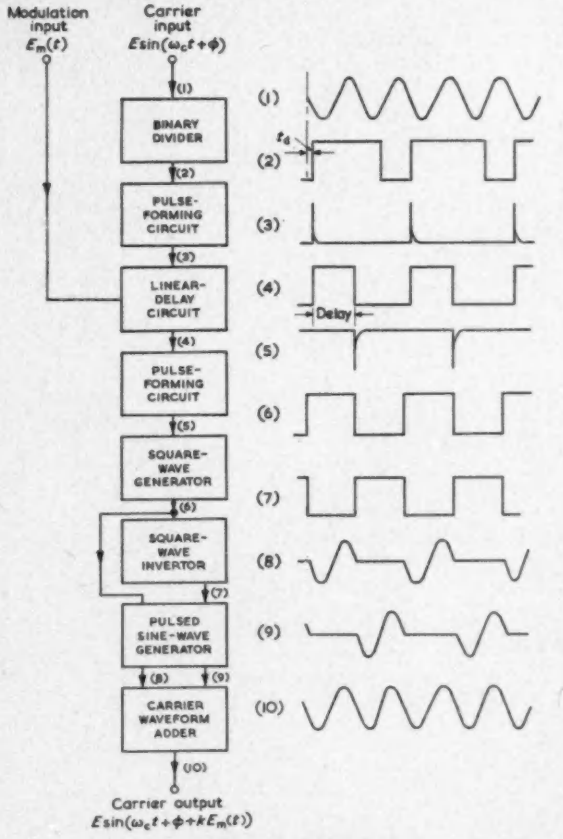


Fig. 1. Arrangement of modulator

receipt of a positive pulse at V_1 control-grid, a fast regenerative action is initiated, whereby the current that was flowing in R_3 is switched into R_1. The voltage step which appears at the anode of V_1 in consequence of the state-change is transmitted by C_1 to drive the control-grid of V_2 negative with respect to the common cathodes. The potential of this grid then recovers exponentially, on a time-constant R_4C_1 towards the anode supply voltage E.

* *King's College, University of Durham.*

When the control-grid of V_2 reaches a potential which is within the grid-to-grid switching potential e_s, of the V_1 control-grid potential, the exponential excursion is abruptly arrested and the circuit snaps back to its initial and stable state. Fig. 3 shows the circuit waveforms, neglecting the effect of stray capacitance.

One point requires further comment. It has been suggested that the current in R_3 when V_2 is conducting is equal to the current in R_1 when V_1 is conducting. This, of

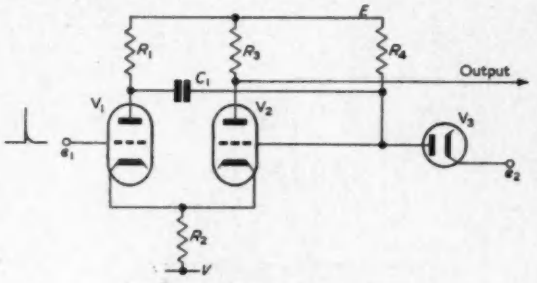
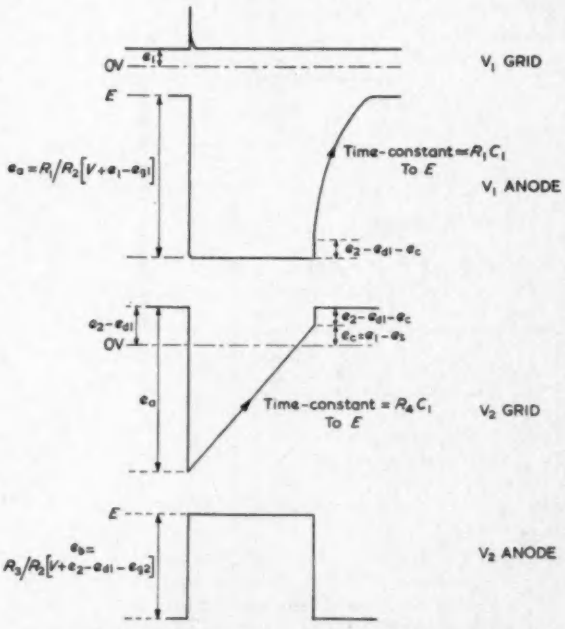


Fig. 2. Cathode-coupled multivibrator



e_{g1}, e_{g2} Grid-cathode potential difference during conduction
e_{d1} Anode-cathode potential difference during conduction (V_3)
e_1, e_2 D.C. bias level
e_s Minimum grid-to-grid potential to cut-off one of the pair

Fig. 3. Multivibrator waveforms

course, can only be approximately true, since the d.c. bias e_2 must be greater than the bias e_1. If the negative supply voltage, V, is made very much greater than the voltage $(e_2 - e_1)$, a constant switching current can be realized within a few per cent. The 'tail' of the cathode-coupled pair is then truly 'long'; I_k, the current in the common cathode resistor R_2, is very nearly independent of the state of the circuit.

A further advantage, gained from returning the common-cathode resistor to a negative supply voltage, is that virtually all of the anode supply voltage is available for the valve and its anode resistor. Large anode swings can therefore be realized without forcing the valve to draw grid current. It is desirable to make e_a in Fig. 3 large, so that changes in e_a, which will occur during the life of the valve, produce an insignificantly small change in the operation of the complete circuit.

Typical circuit values with a CV455 (12AT7) double-triode are: $I_k = 7$mA, $E = 300$V, $V = -300$V. The bias levels, e_1 and e_2, can then conveniently be kept within ± 20V of earth. Voltage swings of up to 100V at the anodes of V_1 and V_2, given to within 3 or 4 per cent by I_kR_1 and I_kR_3 respectively can be safely designed for. The components of the timing network, R_4 and C_1, are designed from considerations of the solution of the simple equation which governs the exponential waveform at V_2 control grid, together with a knowledge of the required mark-to-space ratio of the final output waveform at the anode of V_2.

The circuit of Fig. 2 may thus readily be designed to meet a specific application. The particular 'memory' circuit shown is, of course, only one of a wide range of circuits employing the 'long-tailed-pair' principle. The important feature of these, in relation to the generation and manipulation of waveforms, is that 'a control-grid voltage change of a few volts will serve to switch a near-constant current from one anode to the other, in a stage which is essentially a fast-acting voltage-driven switch'[6].

The Complete Modulator

The circuit diagram of the complete modulator is shown in Fig. 4. It remains to discuss each individual circuit in detail.

Frequency Division

A frequency divider, dividing by two, can be formed from the circuit of Fig. 2 by correct choice of V_1 anode voltage-swing and the time-constant R_4C_1. These quantities are selected so that the circuit, after being triggered into the unstable state, recovers to the stable state after a period of time has elapsed, which is greater than one time-period at the carrier-frequency, but less than two time-periods. The circuit is thus paralysed to alternate triggering half-cycles of the applied waveform. In the particular case of a sine wave synchronizing drive, it is advantageous to trigger at the anode of V_1 rather than at the control grid. In Fig. 4 the sine wave input is shown as being coupled into the anode via a series diode. The carrier is then effectively isolated, by the diode, after the state-change has been initiated.

A further aspect of the multivibrator circuit emerges when the synchronizing waveform is sinusoidal. This is the presence of a small delay, inherent in the circuit, and shown as t_d in Fig. 1. It is inconsequential in the performance of the complete modulator, since it can readily be absorbed into the modulator calibration. The delay must, however, be constant: this implies a constant amplitude sine wave input. Measurements on the circuit have shown that this amplitude should be not less than 20V.

Pulse Forming

Pulses are formed in passive 'differentiating' networks. The design criterion in these is that the time-constant of the RC network involved must be very much less than the time-period of the rectangular waveform from which the pulse is shaped. In the limit the design is set by the pulse attenuation which may be tolerated in the network. Appreciable attenuation results when the time-constant of the pulse-forming circuit becomes comparable with the rise-time of the waveform before differentiation[7].

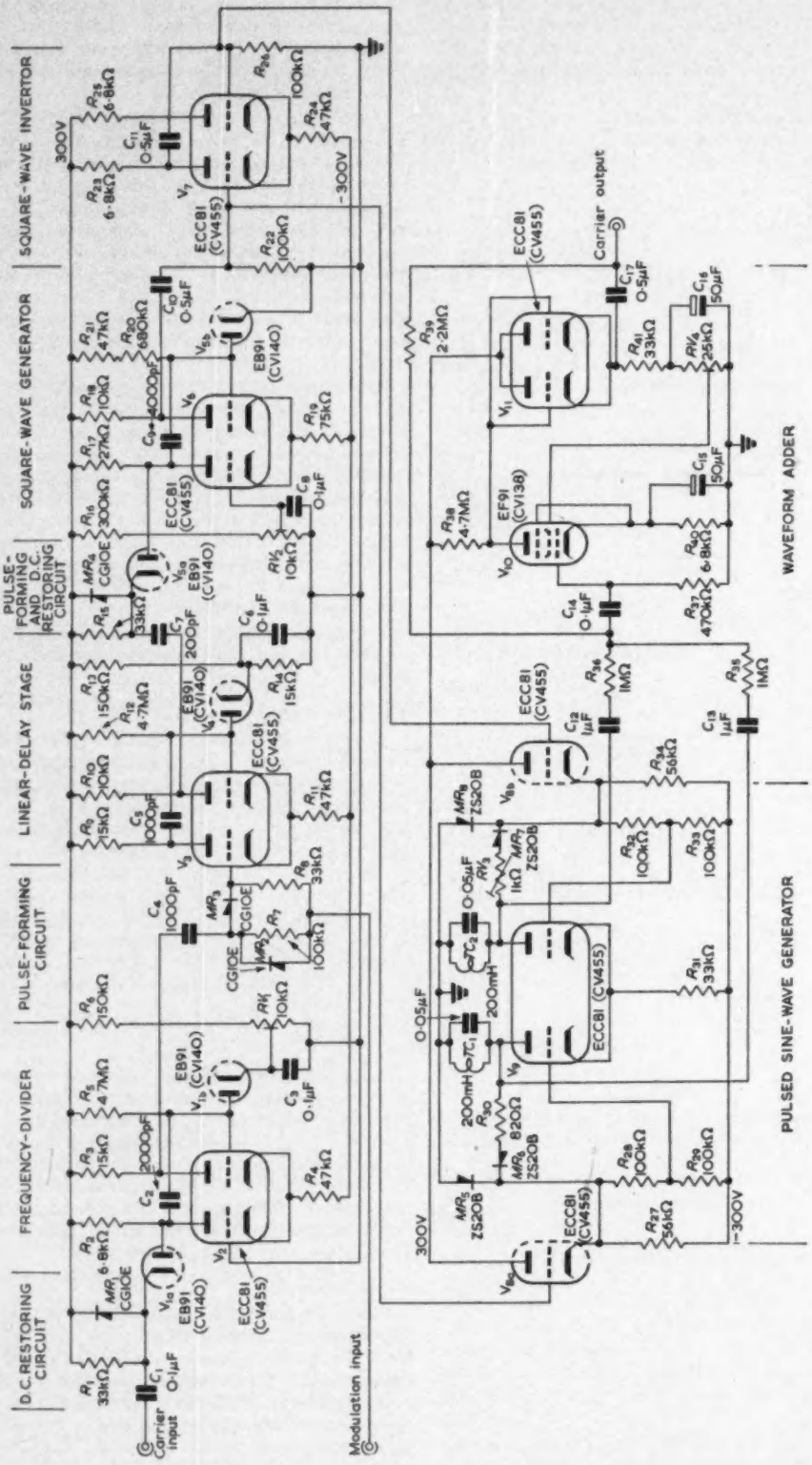


Fig. 4. Audio-frequency phase modulator

Linear Delay

Again referring to Fig. 2, the off-period of V_2 is dependent upon the bias potential e_1, of V_1 control-grid. Three factors working together cause this off-period, the delay-period of the circuit, to be a linear function of e_1 within 1·0 per cent over the restricted range used here.

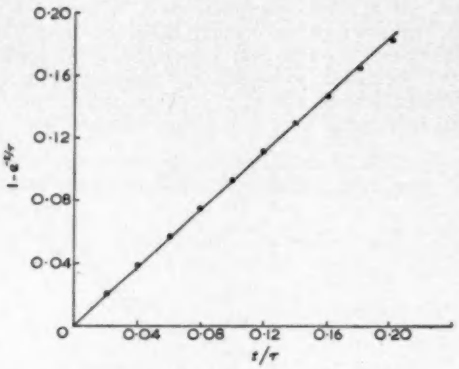


Fig. 5. Graph of $(1 - e^{-t/\tau})$ against t/τ

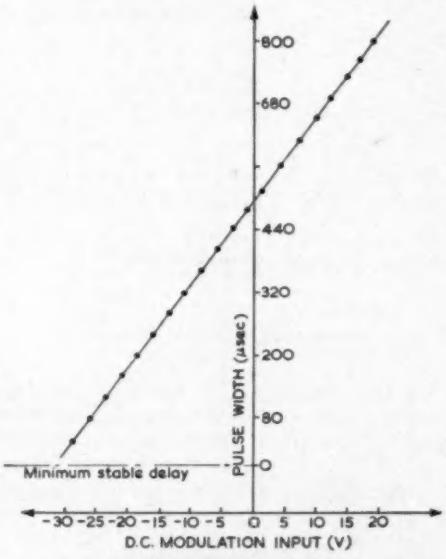


Fig. 6. Delay circuit linearity

Firstly, as e_1 varies, I_k varies in accordance with the relationship:

$$I_k = \frac{e_1 - e_{g1} + V}{R_3} \quad \ldots\ldots\ldots\ldots (1)$$

Thus the magnitude of the voltage step at V_1 anode, and therefore the starting point of the timing waveform at V_2 control grid, is a linear function of e_1.

Secondly, the termination of the delay, when the circuit recovers to its stable state, is controlled directly by e_1.

The third aspect of the delay action is the linearity of the timing waveform itself. For a linear delay it is clear that the timing waveform must be linear, but Fig. 3 shows that the timing waveform is an exponential. It is on this latter point that the Phantastron is normally considered advantageous, since the timing waveform in this circuit is linear to within about 1 per cent over its entire range. In the cathode-coupled delay circuit it is thus imperative to restrict the excursions of V_2 control-grid to the 'bottom' of the exponential, where the departure from linearity is small. Fig. 5 shows a straight-line approximation to $(1 - e^{-t/\tau})$ for small t/τ. Taking account of both the starting potential and the magnitude of the timing waveform varying with e_1, circuit linearity errors should not exceed 1 per cent over the range used.

Finally, in the delay-circuit shown in Fig. 4, the delay has been measured as a function of a d.c. modulation input. Results of these measurements are shown in Fig. 6. The departure from linearity was found to be less than 1 per cent over the total range of delay. This indicates that the linearity of the complete modulator will be of this order.

The performance of the cathode-coupled delay circuit is thus entirely satisfactory for this application. Alternatively a Phantastron delay stage could have been used, although this would have necessitated the addition of a constant d.c. voltage to the modulation input in order to satisfactorily modulate the Phantastron anode potential[8].

Square Wave Generation

Since the delayed edge from the delay circuit is negative-going, then the triggering pulse obtainable is negative. If the cathode-coupled circuit is to be triggered at the control grid, the stable state of the square wave generator must be the reverse of that shown in Fig. 2. This may be achieved by returning the resistor in the timing network to V instead of to E. Alternatively the circuit of Fig. 3 can be triggered with a negative pulse at the anode, as in the frequency divider. The latter arrangement was chosen after measurements on both circuits, because it appears to have a marginally better performance in long-term stability. This possibility arises from the fact that larger anode voltage swings are obtainable in the anode-triggered version. The effect of changes in the grid-to-grid switching potential of the stage, due to valve ageing, is then more effectively swamped out.

The combination of the time-constant $(R_{20} + R_{21})C_9$, the voltage step in R_{17}, and the control-grid bias levels of the stage are designed to establish an output waveform, at the free anode of the coupled pair, of unity mark-to-space ratio. With regard to drift stability of the square wave generator during operating periods of a few hours, measurements carried out with the complete modulator in circuit revealed that, over a ten-hour period, the change in mark-to-space ratio was less than 0·1 per cent.

Square Wave Inversion

It is necessary to form a paraphase square wave, to afford a push-pull drive to the sine wave generator. The output from V_6 is thus inverted in V_7. Since controlled timing is unnecessary in this stage, the time-constant of the circuit $R_{26}C_{11}$ in the positive feedback loop is designed to be much greater than the time-period of the square wave input. In the absence of the synchronizing waveform, the stage would run freely at some frequency much lower than the carrier-frequency.

Pulsed Sine Wave Generation

Having thus obtained square waves, which may be delayed in time relative to the carrier input in accordance with a modulating voltage, it is now necessary to use these waveforms to synchronize a sine wave generator. The generator comprises two tuned-circuits which are switched into oscillation for one cycle at a time[3,5].

An oscillogram of the pulsed oscillations in one of the tuned circuits is shown in Fig. 7.

It is important in the design of the generator to ensure

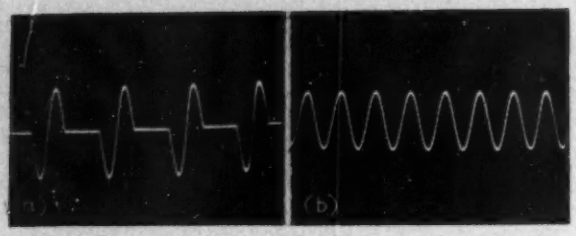


Fig. 7. Modulator waveforms
(a) Pulsed oscillations in tuned circuit. (b) Final carrier output

that each tuned circuit has the same current switched into it. The peak voltage induced in each is then the same, if the tuned circuits are identical. A near-constant switching current is readily achieved in a cathode-coupled stage, operating without regeneration, and supplied with a push-pull control grid drive. Unavoidable disparity of 2 or 3 per cent in the construction of the tuned circuits is balanced by RV_3. Damping is obtained in silicon diode switches which, when the diodes are in the conducting state, present low resistance to each tuned circuit. In this period when free oscillations are blocked, a small residue of voltage in the diode switch establishes a current in the tuned circuit inductor. This current is of little significance in the operation of the sine wave generator, providing that it is small relative to the switching current from the cathode-coupled pair. The temperature and time dependent parameters of the diode then play only a small part in determining the amplitude of the pulsed oscillations. The use of silicon diodes and additional series resistance R_{39} and RV_2 reduces the current due to the diode switch to less than 4 per cent of the nominal switching current. A 25 per cent change in this unwanted current would then change the output waveform by only 1 per cent.

The requirement of a low resistance across the tuned circuit, during the damping period, is the reverse of the requirement of very high resistance across the circuit, when it is oscillating freely. The need for lightly damped oscillations necessitates the use of high Q-factor inductors in the tuned circuits. Suitable inductors may be conveniently wound on small Ferroxcube pot cores; those constructed showed a measured Q-factor in the range 200 to 300, which is adequate for this application.

It is necessary that the two tuned circuits be accurately adjusted to resonate at the carrier frequency. If the circuits are not so adjusted, the output waveform is adversely affected. With correct tuning of each tuned-circuit, the measured harmonic content of the modulator output waveform was as shown in Table 1.

Waveform Addition

The two waveforms from the sine wave generator are compounded in a 'virtual earth'[9] type of adder comprising V_{10} and V_{11}. The screen grid of V_{10} is maintained at about 10V positive with respect to earth, which serves to starve[10] the pentode of anode current. A large-valued anode load resistor can then be used to realize a voltage gain of about 1 500 times from this single stage. In consequence of the use of a large anode resistor, the open-loop gain-frequency-response of the starvation amplifier is 3dB down on its maximum value at 2·5kc/s.

TABLE 1
Harmonic Content of Carrier Output

HARMONIC	MAGNITUDE OF HARMONIC RELATIVE TO FUNDAMENTAL (per cent)
1st sub-harmonic	0·85
2nd harmonic	0·48
3rd harmonic	0·15
4th harmonic	0·13
5th harmonic	0·10

Modulator Linearity

The linearity of the modulator has been measured by a static test in which the modulation input was a direct voltage. Results indicate that the departure from linearity was less than 1 per cent over a range of carrier phase-shift of 450°. The carrier phase-shift was measured with a magslip arrangement in conjunction with a double-beam oscilloscope functioning as a coincidence detector. Any phase-angle may be selected by appropriate positioning of the magslip rotor, and this phase-angle may be accurately observed on a 360° protractor mounted on the rotor shaft. A single frequency is involved, and this allows the magslip drives to be carefully adjusted to yield a precision control of phase in the magslip.

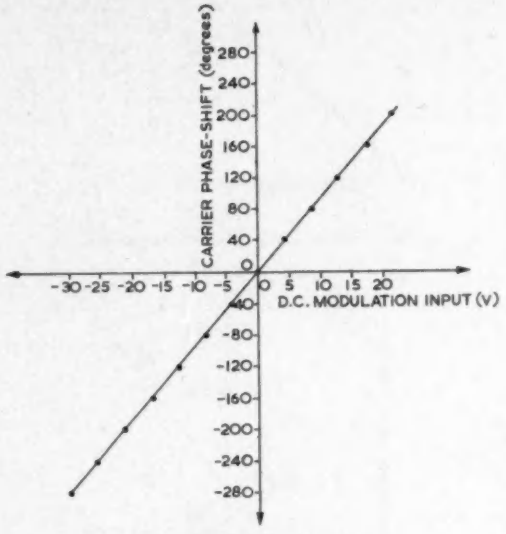


Fig. 8. Modulator linearity

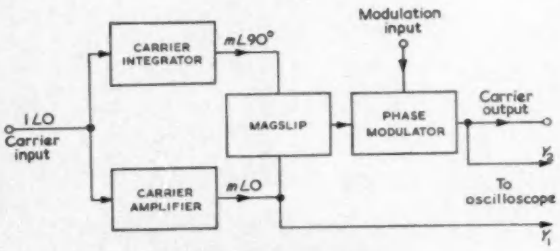


Fig. 9. Phase measurements

Bandwidth Considerations

The modulator carrier frequency f_o, of 1 592c/s imposes limitations on the modulation frequency range over which accurate phase modulation can be maintained. Due to the presence of the frequency divider, the modulation is sampled at the rate of 796 times per second. Since the modulator is incapable of instantly responding to changes in modulation which occur during the time-period Δt, between the sampling pulses, the carrier phase-shift changes in discrete increments. Fig. 10 depicts the quantized carrier phase-shift deviations in the particular case of a sine wave

modulation. The discrepancy between the actual phase-shift and the phase-shift demanded by the modulation, shown at one particular instant in time as $\Delta\phi$, changes during the modulation cycle. Thus the accuracy of the modulator varies throughout the modulation cycle, and is greatest when the rate of change of modulation with respect to time is smallest. In assessing the continuous-wave bandwidth of the unit, it is necessary to specify some instant in the modulation cycle at which the errors are to be computed. Further, it is more representative of the truth to consider not the total phase step at the selected instant in time, but one-half of this[11], and correspondingly, one-half of the time-period between sampling pulses. The error in phase-shift expressed as a percentage of the total phase-shift during one complete modulation cycle may then be written as:

$$(\Delta\phi/2)/\phi t = \tfrac{1}{2}\left[\sin(\omega_m t) - \sin(\omega_m t - \omega_m(\Delta t/2))\right] \quad \ldots\ldots\ldots\ldots (2)$$

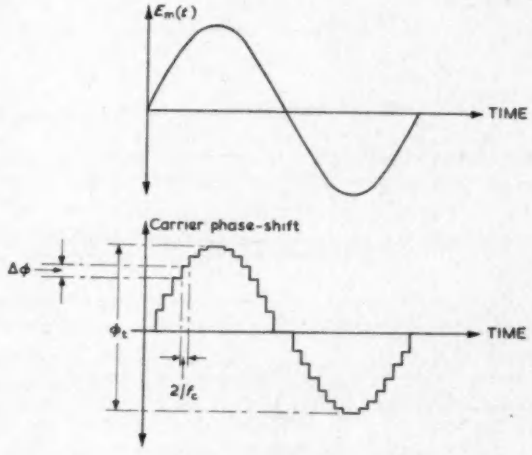


Fig. 10. Bandwidth considerations

The solution of equation (2) demonstrates that with $\omega_m t = \pi/3$, the linearity of phase modulation is maintained within 1 per cent of its value at d.c. for modulation frequencies extending from zero up to 10c/s.

The response to ramp and step function inputs may be considered in a similar way. A step change in modulation could, on the one hand, result in a rapid, near-instantaneous change in carrier phase-shift. On the other hand a maximum possible delay of $2/f_c$, i.e. 1·26msec, may result, depending on the instant in the carrier waveform train when the step occurs. It is to be noted that whatever the nature of the carrier phase-change, the magnitude of the voltage output of the modulator remains strictly constant.

Finally, it may be remarked that the use of the pulsed sine wave generator instead of a synchronized free-running oscillator avoids problems associated with the bandwidth of the latter system.

Application

The modulator described was designed to fulfil the rather specialized purpose of modulating the phase of a carrier system in a network analyser in conformity with solutions obtained from an analogue computer; thus providing the link between the two analogue systems. It is hoped that a discussion of the modulator and circuit techniques employed may prove to be of wider interest than this specialized application directly involves.

Acknowledgments

The author is grateful to Professor R. L. Russell for the laboratory facilities in the Department of Electrical Engineering, King's College, University of Durham. Thanks are also due to Mr. F. J. U. Ritson for discussions on several aspects of the work.

Invaluable advice on the design of 'long-tailed-pair' multivibrators, received from Mr. R. C. Foss, is gratefully acknowledged.

REFERENCES

1. Gordon, J. F. A New Angular-Velocity-Modulation System Employing Pulse Techniques. *Proc. Inst. Radio Engrs. 34*, 328 (1946).
2. Van Ness, J. E., Peterson, W. C. The Use of Analogue Computers in Power-System Studies. *Trans. Amer. Inst. Elect. Engrs. 75*, 238 (1956).
3. Corless, K. G., Aldred, A. S. An Experimental Electronic Power-System Simulator. *Proc. Instn. Elect. Engrs. 105A*, 503 (1958).
4. Blumlein, A. D. Brit. Patent Spec. 482, 740 (1938).
5. White, E. L. C. Brit. Patent Spec. 535, 778 (1941).
6. Newman, E. A., Clayden, D. O., Wright, M. A. The Mercury-Delay-Line Storage System of the Ace Pilot Computer. *Proc. Instn. Elect. Engrs. 100*, Pt. 2, 445 (1953).
7. Dillistone, D. C. Approximate Waveform Solutions for Diodes in Pulse Circuits. *Electronic Engng. 31*, 607 (1959).
8. Chance, B., et al Waveforms, M.I.T. Radiation Laboratory Series, 19, 140. (McGraw Hill, 1949).
9. Williams, F. C., Ritson, F. J. U. Automatic Strobes and Recurrence-Frequency Selectors. *J. Instn. Elect. Engrs. 93*, Pt. 3a, (1946).
10. Kaufer, G. E. Starved Amplifiers. *Electronic Engng. 26*, 498 (1954).
11. Black, H. S. Modulation Theory, Bell Lab. Series, 60, (Van Nostrand 1953).

Automatic Printed Circuit Drill

A new fully automatic 'printed circuit drill,' designed for fast and economical drilling of component fixing holes in printed circuit boards, has been introduced by Ferranti Ltd.

Basically, the machine consists of two drilling heads allowing either tandem or single spindle working; a hydraulically-operated co-ordinate table carrying the printed circuit boards which is automatically moved to bring the board hole centres in turn below the drills; and a control system for the drilling action and table movement.

The drilling table, which covers an area of 20in by 14in, is moved parallel with or at right angles to the front of the machine by two hydraulic jacks. Accurate positioning of hole centres under the drills is carried out in two stages. Firstly, rough positioning is achieved by the use of a perforated template and photo-electric cell. Secondly, accurate positioning is produced by a mechanical indexing system using the meshing of a half nut and precision rack. A positional accuracy of ± ·001in can be obtained and repeatability is within ·001in.

Drilling is carried out to a grid system, the holes being drilled in a systematic pattern of rows and columns. The basic spacing between rows of the grid system is determined by the pitch of the thread of the precision rack associated with row alignment. A typical pitch is 20 threads per inch giving a spacing between rows of 0·050in or multiples thereof. A similar precision rack is used for column alignment.

The perforated template is mounted on an extension of the drilling table and whenever a hole in the drilling area of the template coincides with the light beam, the photo-electric cell is stimulated and provides a signal to the machine's control system. This signal initiates: (1) The cut-off of the oil flow to the hydraulic jacks stopping the drilling table. (2) The application of oil to the half nut mechanism to mesh the half nut with the precision rack, thereby accurately locating the table and locking it in position. (3) The drilling action by switching electrical power to the drills.

On completion of the drilling action, a signal from the drilling head is fed to the control system to release the half nut from the rack and to re-start the flow of oil to the jacks which move the table.

As mentioned previously the pattern of holes is systematically drilled row by row. When a row is completed, the drilling table moves to bring the adjacent row into line with the drilling heads. Movement of the drilling table to bring the next row into line is controlled by two columns of row marker holes in the template. Each row of the drilling pattern has an associated row marker hole. These holes stimulate the photo-electric cell and the resulting signal causes the table to move up to the next row and along that row.

The machine can accommodate a single stack—up to ¼in deep—of one or more printed circuit boards with dimensions of up to 12½in by 18in. Alternatively, it can accommodate two stacks of identical boards for simultaneous drilling—each with dimensions up to 12½in by 8½in.

A Transistorized Data Amplifier

By H. Fuchs*, B.Sc., Ph.D., and K. B. Rhodes*, B.Sc.

This article describes the design of a transistorized data amplifier suitable for amplifying microvolt signals from thermocouples, pressure transducers and other sources.

It discusses the main requirements of a data amplifier and describes how these have been met in the present design.

(Voir page 830 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 837)

As industry's need for measurement and control grows, an ever increasing range of electric transducers is becoming available, enabling physical parameters such as temperature, pressure, strain, flow rate, etc., to be obtained as voltage signals proportional to the original parameter.

However these signals are, in general, of a very low magnitude and before they can be used in data collection, data processing and display systems, amplification is required.

The requirement for a data amplifier suitable for amplifying signals from transducers may be listed as follows:—

(1) The amplifier should be capable of accepting a signal of ± 10mV full scale and amplifying it by a factor of up to 1 000 and an accuracy of 0·1 per cent. This essentially means that the amplifier must not introduce drift and noise of more than 10μV referred to its input.

(2) The amplifier must have a fairly high input impedance in order not to load the signal sources from which it will work.

Most transducers have an output impedance in the region of 10 to 1 000Ω and in order not to introduce loading errors greater than the permissible errors, the input impedance of the amplifier must be in excess of 1MΩ.

(3) Since in general the transducer will be on plant, some distance away from the amplifier, it will be necessary for the amplifier to reject pick-up on the signal lines. The amplifier must, therefore, have a floating input, accepting two lines from the transducer and the impedance to earth must be balanced in order that pick up voltages develop equal currents across each input impedance.

(4) Although the amplifier input must be balanced and floating, the output must in general be referred to earth voltage, since the output signal will be required to operate other measuring equipment whose inputs will, typically, be with respect to earth voltage.

(5) In order to permit the amplifier to be useful over a wide range of measurements, a bandwidth extending from d.c. to at least 10kc/s is necessary and over this bandwidth the accuracy of the amplifier should be substantially the same as at d.c.

System Description

In order to construct an amplifier whose input is both balanced and floating and whose output is with respect to earth voltage, an arrangement of the sort shown in Fig. 1 will be necessary.

The input resistors R_1 and R_2 are connected to the two differential inputs of a drift corrected transistorized d.c. amplifier. In order to stabilize the gain of this amplifier, feedback is required to both inputs. If this feedback were obtained by having a push-pull output to the amplifier, it would not be possible to earth one of the output terminals, without at the same time, demanding that neither of the inputs may be earthed.

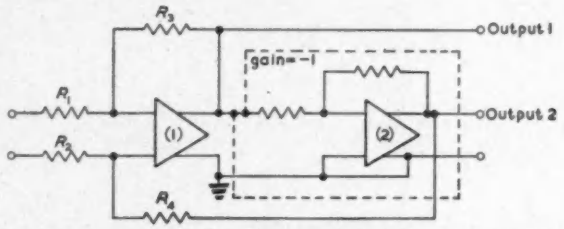


Fig. 1. Arrangement to achieve a balanced and floating input with an output referred to earth

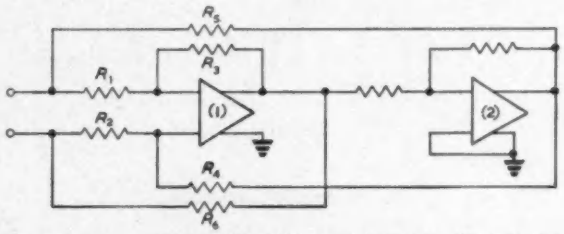


Fig. 2. Arrangement to provide a high input impedance with low value input resistors

Feedback is, therefore, provided to one of the input terminals, from one of the amplifier output terminals, the other output terminal being earthed.

Feedback is provided to the second input terminal from the output of a further amplifier having a gain of exactly − 1, set by feedback resistors.

In this way the output terminals of amplifier No. 1 and amplifier No. 2 provide signals with respect to earth out of phase by 180°. It is therefore possible to obtain both a signal with respect to earth and a push-pull signal, and the input of the amplifier is not only floating but completely balanced, that is to say that the impedances from the input terminal to earth are equal.

It transpires that because of the high gains required and because of the low input impedances of transistor amplifiers, the resistance of R_1 and R_2 can only be in the region of 1kΩ if the noise level of the amplifier is kept at a low value. It is therefore necessary to achieve the high input impedance required of this amplifier, by the use of positive feedback as shown in Fig. 2. The resistors R_5 and R_6 are chosen in such a way as to re-establish exactly the current at the input terminals, which cancels out the current drawn by the 1kΩ input resistors.

In this way a practical input impedance of some 3MΩ

* *Blackburn Electronics Limited.*

can be achieved. The gain stability of the amplifier will obviously be a function of the internal gain of the amplifier and the gain stability of the feedback and input resistors. The internal gain of the amplifier at d.c. is arranged to be in excess of 5×10^6 and the stability of the resistors is assured by the use of precision wirewound components having an accuracy of 0·1 per cent.

In order to avoid the inevitable drift which any directly coupled amplifier would suffer, due to aging of components, changes in temperature, etc., the input signal, apart from being applied to a directly coupled amplifier is also

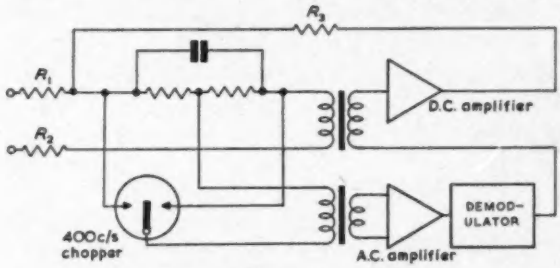


Fig. 3. Arrangement to reduce drift

chopped with a 400c/s chopper relay and applied, via a tuned, carrier amplifier and de-modulator, back to the input of the directly coupled amplifier, in such a sense as to cancel any drift.

The arrangement is shown in Fig. 3.

Circuit Description

A complete circuit diagram of the amplifier is shown in Fig. 4.

The differential input signal is applied to terminals *A* and *B*. Resistors R_{55} and R_{56} are the basic input resistors of the amplifier with RV_{21} and RV_{22} permitting a fine adjustment to improve the in-phase rejection ratio.

Banks S_{1b} and S_{1d} select different input resistors, S_{1a} and S_{1c} selecting different negative feedback resistors and S_{1e} and S_{1f} selecting different positive feedback resistors thus enabling the gain of the amplifier to be varied to the values 1 000, 300, 100, 30 and 10.

The differential input signal is applied to the primary of transformer T_3. High frequency signals are allowed to pass through the transformer and are then applied to the base of VT_{13} connected as an amplifier. The output of this stage is then applied to VT_{14} connected as an amplifier with some series feedback.

The output of this stage is applied to the base of VT_{15} connected as an emitter-follower with the collector voltage held by resistors R_{68} and R_{69}.

The output of this stage is applied to VT_{16} connected as an amplifier which in turn is applied to VT_{17} connected as an amplifier, the emitter being held by Zener diode MR_{19}.

The output of this stage is finally fed to the base of VT_{18} connected as an amplifier. The feedback is taken from the collector.

Circuits to stabilize the amplifier against feedback oscillations are provided on the collector of VT_{13}, the collector of VT_{14} and the collector of VT_{16}.

The stabilizing networks on VT_{16} are arranged to be selected by S_{1h} to alter the stabilizing networks as the total gain of the amplifier is changed in order to maintain an adequate gain and phase margin under all conditions.

Low frequency signals which are not able to pass through transformer T_3 are chopped across resistors R_{57} and R_{58} by chopper CH_1 running at 400c/s and the resulting square wave applied to the primary of transformer T_4. The output signal from this transformer is then applied to the base of VT_{19} connected as an amplifier which drives VT_{20} connected as an amplifier with series feedback. The output of this stage is applied to VT_{21} connected as an emitter-follower the collector being held by resistors R_{81} and R_{82}.

The output of this stage is applied to VT_{22} connected as an amplifier.

The amplified square wave obtained from stage V_{22} is de-modulated by the synchronous bridge rectifier MR_{17} and MR_{18} and applied via a tuned feedback circuit to the secondary of transformer T_4. This is the tuning signal.

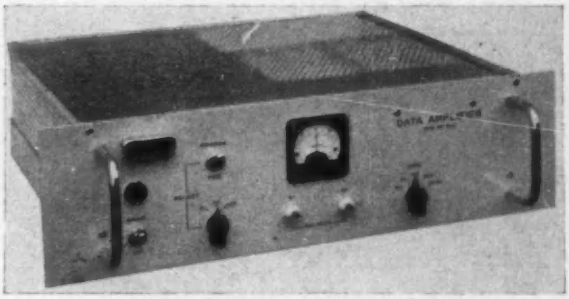
The rectified and smoothed output of VT_{22} is also applied to the primary of transformer T_3, this voltage being the drift correction signal.

Amplifier No. 2 shown on the right-hand side of Fig. 4 is in principle identical to amplifier No. 1, except that no gain switching is required since this amplifier is always connected to have a gain with feedback of -1. The required internal gain is also lower resulting in fewer stages. Further, the output of this amplifier is an emitter-follower VT_{27} providing the power output for the whole amplifying system.

Switch S_2 switches each amplifier input in turn to earth potential for balancing purposes and switch S_3 changes the sensitivity of the 50-0-50μA meter from 10V full-scale to 50mV full-scale.

Potentiometers RV_{19} and RV_{20} permit independent balancing of each amplifier.

During the development of the amplifier it was found that both 400c/s and 50c/s noise was picked up in the input circuit of the amplifier. After careful investigation, each amplifier was separately screened in, first a copper box, and inside this, a Mumetal box.



The complete amplifier

The chopper relays and associated input resistors R_{57} and R_{58} are separately screened in a similar double box.

The input transformers T_3, T_4, T_5, and T_6 are themselves Mumetal screened with a very high insulation between each winding.

The power supplies are shown at the bottom of Fig. 4.

The mains transformer T_1 provides four secondary windings. The first, provides a half wave rectified, Zener diode stabilized (MR_3) -20V line capable of delivering 10mA. The second and third windings provide full-wave rectified outputs stabilized by feedback amplifiers whose references are taken from Zener diodes MR_8 and MR_{13} at $\pm$ 15V 50mA.

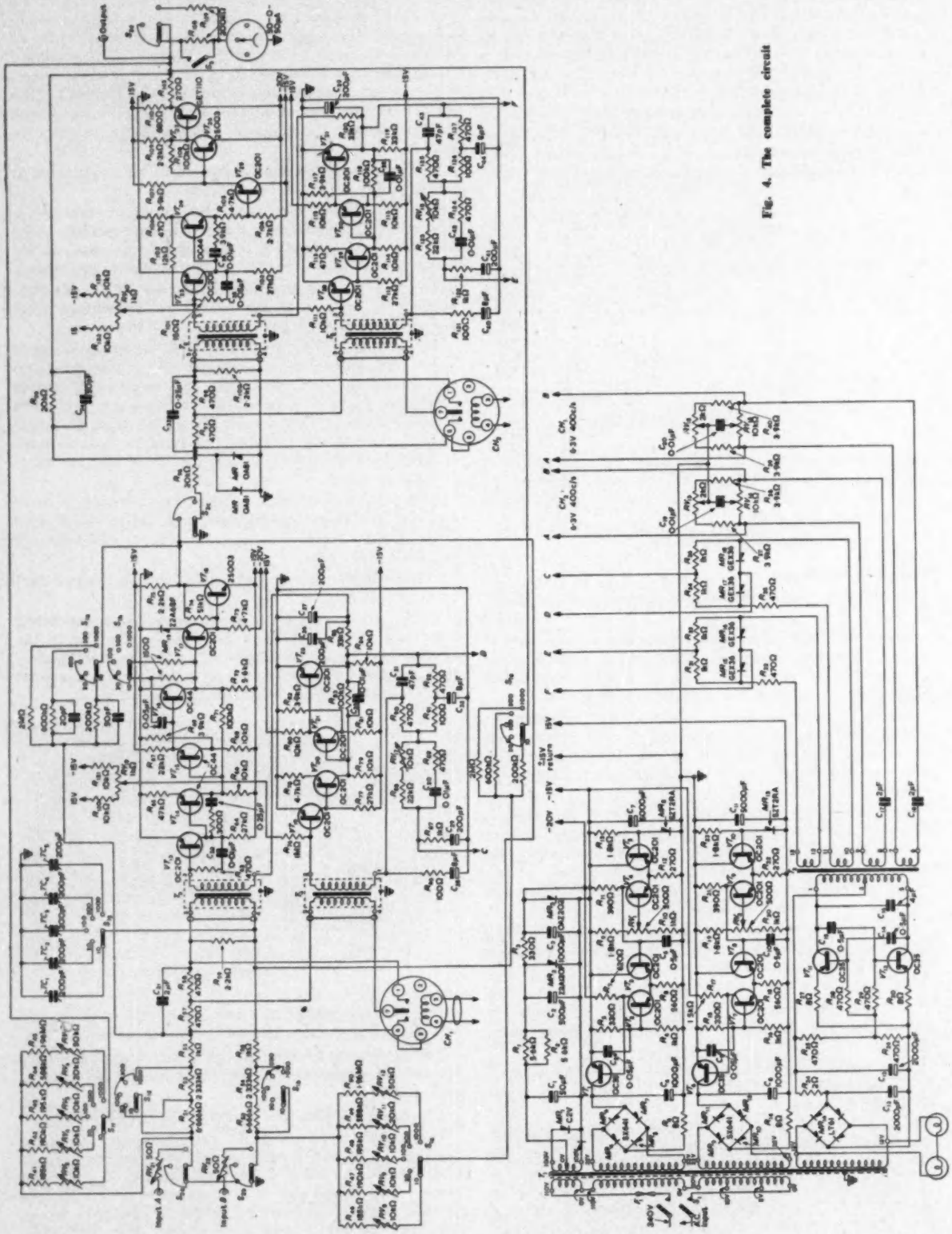


Fig. 4. The complete circuit

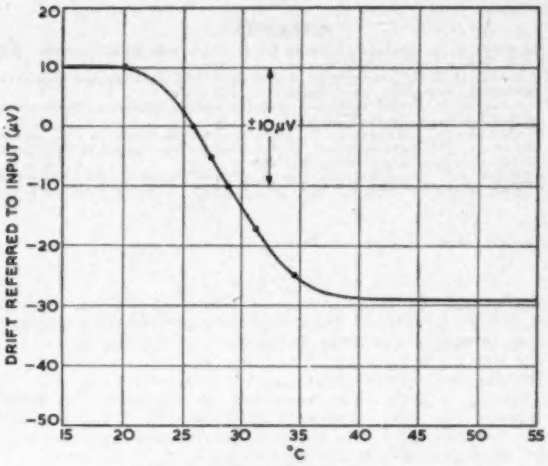


Fig. 5. Drift with temperature (gain 1 000)

The last winding provides full-wave rectified unstabilized power for the 400c/s oscillator VT_{11} and VT_{12} for driving the chopper relays CH_1 and CH_2 and the demodulator circuits, MR_{15} and MR_{16} and MR_{17} and MR_{18}.

Performance

Fig. 5 shows the drift of the amplifier with temperature and it will be seen that over a temperature range of 15°C the total drift is within ± 10μV.

Fig. 6 shows the drift history over two and a half days. The ambient temperature only varied ±5°C in this environment and it will be seen that the total drift with time was ± 4μV.

Table 1 shows the r.m.s. noise levels referred to the output, at the five different gain positions and it will be seen that the noise does not introduce an error greater than 0·1 per cent of the full-scale output.

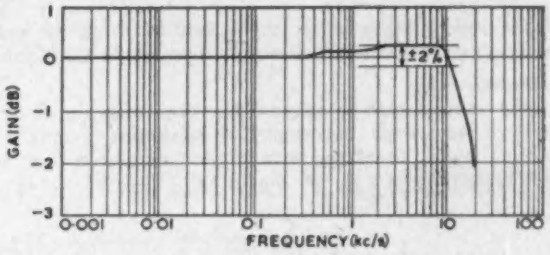


Fig. 7. Frequency response at a gain of 1 000

TABLE 1

Amplifier Noise at the Output (10V full scale)

GAIN	BANDWIDTH 100 c/s (mV r.m.s.)	BANDWIDTH 10kc/s (mV r.m.s.)
1000	5	15
300	1·6	6
100	0·5	1·3
30	0·3	1
10	0·3	1

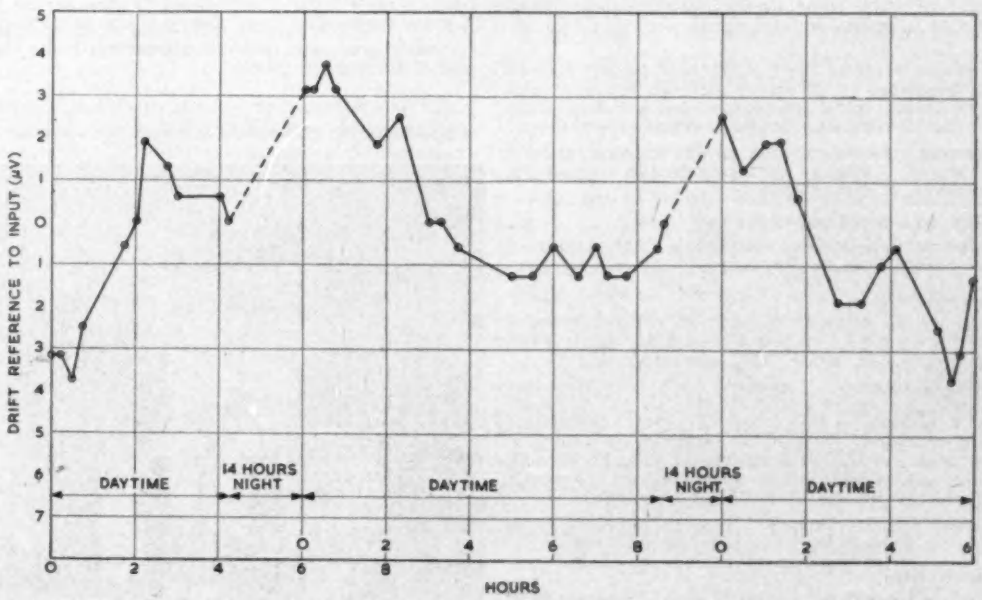
Fig. 7 shows the frequency response of the amplifier at a gain of 1 000; the frequency response on the other gain positions is substantially identical.

Conclusion

An amplifier has been described which satisfies all the requirements for a d.c. data amplifier operating from low level signals obtained from transducers. A high input impedance, a balanced floating input with a high common mode rejection ratio and a high gain linearity ensures accuracy of measurement.

Five different gain positions permit the amplifier to be used in many different applications and the use of transistors ensures a high degree of reliability. The noise and drift figures are such that extremely low levels may be measured with considerable precision and the band-

Fig. 6. Drift with time (gain 1 000)



width permits the amplifier to be used for vibration and noise measurements as well as for quasi static quantities.

Acknowledgments

The authors wish to acknowledge the assistance of the staff of the Design Laboratory of Blackburn Electronics Limited and to thank the Directors for permission to publish this article.

REFERENCES

1. Blecher, F. H. Transistor Circuits for Analogue and Digital Systems. *Bell Syst. Tech. J. 35*, 295 (1956).
2. Chaplin, G. B. B., Owens, A. R. A Transistor High Gain Chopper Type D.C. Amplifier. *Proc. Instn. Elect. Engrs. 105B*, 258 (1958).
3. Okada, R. H. Stable Transistor Wide-Band D.C. Amplifiers. *Trans. Amer. Inst. Elect. Engrs. 79*, Pt. 3, 26 (1960).
4. Glucharoff, T., Gilbert, G. P. The Use of Silicon Diodes in D.C. Modulators and their Applications to Drift Correctors for Computing Amplifiers. *Proc. Instn. Elect. Engrs. 107C*, 82 (1960).
5. Burwen, R. S. Amplifiers for Strain Gages and Thermocouples. *Electronics 32*, 43 (24 July 1959).

A New Meteorological Radar

A radar equipment designed for meteorological purposes has been developed by Cossor Radar and Electronics Ltd and orders for eight such equipments have been received for installation in New Zealand and islands in the southern Pacific.

This equipment, type C.R.353, which operates in the 10cm band, is based on the requirements and recommendations of meteorological authorities throughout the world and is constructed in the form of basic and optional units. These can be variously assembled to measure the direction and speed of winds in the upper atmosphere and to provide other facilities, including weather surveillance radar, ranging from the simplest, to those required by a component station of a major weather reporting system. In this way the greatest possible utilization of a substantial piece of capital equipment is realized.

In the windfinding role the C.R.353 is used to detect and track a passive reflector carried by a free balloon, thereby making it possible to compute wind velocity at all heights up to the bursting point of the balloon.

When the balloon is released it is sighted manually by a 'putting-on' device to which the radar aerial is slaved. Once the target has been sighted by the radar it is tracked either manually by the operator, or automatically by the equipment. The three positional co-ordinates of the reflector are displayed on visual indicators on the Data Presentation Unit. The bearing and elevation indications are at intervals of 0·05°. A timing device is also incorporated in the display arrangement which provides timing pulses which freeze all the indicators at regular intervals so that the co-ordinates of the target, at the instant of each pulse, can be easily plotted.

When required for weather observation the equipment is used to observe the position of storm centres and to assess densities of clouds and rain precipitation. The radar echoes are displayed on a plan position indicator with a 12in screen. This receiving unit incorporates iso-echo circuits which enable the operator to make cloud density determinations. Cloud heights can be estimated by varying the vertical tilt of the aerial.

The maximum range of the C.R.353 as a weather radar is principally determined by the earth's curvature and in practice is about 200 nautical miles. Intermediate switched range scales of 100, 50 and 25 nautical miles are provided.

The displayed p.p.i. information can be remoted by cable or radio link and, if required, arrangements can be made for remote operation of the equipment.

The C.R.353 as a Windfinding Unit

When used as a windfinding unit the C.R.353 consists of four main assemblies as follows:—

The Aerial Assembly

The aerial consists of an 8ft diameter paraboloidal reflector illuminated by an offset rotating dipole. The dipole offset produces a conical scan with a 'half split' angle of 1·5°.

The reflector assembly is mounted on a horizontal axis about which it can be rotated from zero to 90° elevation. The whole is mounted so that it can be rotated continuously in the horizontal plane. Provision is made for the alignment, by optical means, of the physical axis of the reflector with its radar axis and for the accurate determination of the angle of elevation of the reflector by means of a clinometer.

The assembly can be operated in winds of up to 75 knots and will not be damaged by winds of up to 120 knots.

Transmitter-Receiver

This comprises an 800kW transmitter in the frequency band 2780 to 2820Mc/s and a receiver with a noise figure of 9dB and an i.f. of 30Mc/s. There are two pulse lengths available: 1μsec at 500p/s and 2μsec at 350p/s.

Indicator and Control Unit

This is a desk unit, on which are mounted the aerial controls, the aerial alignment indicator, aerial bearing and elevation indicators, and the A-scope indicator, together with various basic controls.

The Aerial Alignment Indicator consists of two centre-zero meter movements, each driving a pointer, positioned so that the pointers intersect at right-angles in the centre of a dial when both movements are un-energized. Inequalities of signals received from opposite quadrants of the conical aerial beam give rise to bearing and/or elevation misalignment signals which energize one or both of the meter movements and displace the point of intersection of the pointers from the centre of the dial.

Data Presentation Unit

This is also a desk unit. On it are mounted the coarse and fine bearing and elevation indicator dials, the range indicator, the timing unit and a meter panel.

The bearing and elevation indicators are synchro receivers driven by the synchro transmitters at the aerial head: the fine graduations in each case are at intervals of 0·05°.

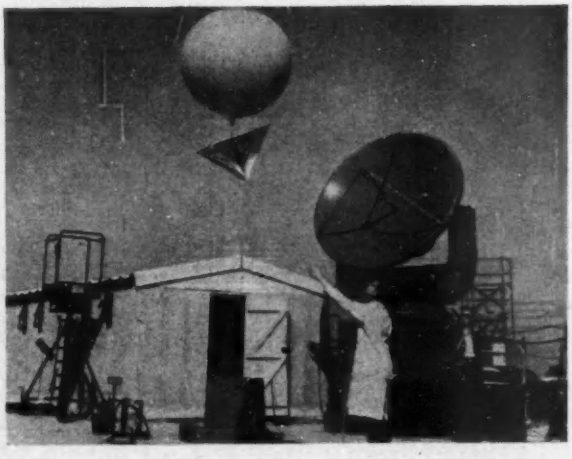
The range indicator displays the range in metres as a six figure number correct to the nearest 25 metres. The maximum slant range is 250km.

The Basic Weather Radar Unit

This consists of the basic windfinding unit together with a p.p.i. Display Unit which is a desk unit similar in construction to the Data Presentation and Indicator and Control Units. It incorporates a 12in diameter p.p.i. with a direct-coup'ed fixed-coil deflexion system. On this can be displayed targets at ranges up to 200 nautical miles (370km). Intermediate switched range scales of 100, 50 and 25 miles are also provided. A north marker and range rings can also be displayed.

Iso-echo contour circuits are incorporated in the video mixer unit of the display system.

A balloon being released and about to be tracked by the aerial



Silicon Junction Diodes as Variable Capacitors

By J. Registrar*

The physical mechanism of the capacitance appearing at semiconductor junctions is explained. Expressions are given defining barrier width and capacitance for various forms of junction. Methods of measuring this property are suggested and the interdependence of Q, losses and capacitance with temperature are discussed. Finally, several applications are shown, illustrating the use of silicon diodes as variable capacitors.

(Voir page 831 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 838)

IT is well known that semiconductor junction rectifiers exhibit charge storage properties[1]. The behaviour of a pn junction barrier can be likened to that of a capacitor having the p and n bodies of semiconductor material as parallel plates separated by the high resistivity dielectric of the barrier itself. In a metal plate capacitor, the charge sheets on the opposing faces are infinitely thin, whereas in a pn junction they are of finite thickness, being distributed throughout the space charge regions on either side of the junction interface.

The inherent capacitance of the junction is dependent on barrier width which in turn is a function of the applied bias voltage. With the application of reverse bias, the barrier voltage step is increased along with the barrier field. This is brought about by the uncovering

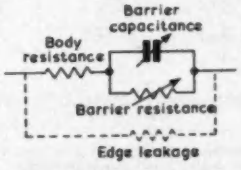


Fig. 1. Equivalent circuit showing the electrical characteristics of a semiconductor rectifier

of more empty donors in the n-type material and filled acceptors in the p-type material. The space charge regions expand, separating 'the plates' of the equivalent capacitor. Increasing the applied reverse voltage thus reduces the capacitance of the junction[2,3].

The electrical behaviour of a rectifier can be represented by the equivalent circuit in Fig. 1.

As capacitance is inversely dependent on barrier width, it is imperative that the latter parameter be known and controlled when diodes are designed, *ab initio*, as capacitors.

By application of Poissons equation:

Barrier Width (in centimetres)

$$= 1{\cdot}05 \times 10^{-6} \left\{ \frac{e(V_o - V_a)}{2\pi q\,(N_a + N_d)} \right\}^{\frac{1}{2}} \{(N_a/N_d)^{\frac{1}{2}} + (N_d/N_a)^{\frac{1}{2}}\} \quad \ldots\ldots\ldots\ldots (1)$$

where e is the dielectric constant of the semiconductor,

V_o is the contact potential barrier in the absence of reverse bias, V_a is the reverse bias and q is the charge in coulombs,

N_a and N_d are the acceptor and donor concentrations in the n and p space charge regions of the barrier.

In a symmetrical barrier, the capacitance per unit area:

$$C = 1{\cdot}05 \left\{ \frac{e \cdot q \cdot N}{16\pi\,(V_o - V_a)} \right\}^{\frac{1}{2}} \mu\text{F/cm}^2 \quad \ldots\ldots (2)$$

When the barrier is unsymmetrical by non-equality of the doping concentrations on either side of, for example, a diffused junction:

$$C = 1{\cdot}05 \left\{ \frac{e \cdot q \cdot N_d}{8\pi\,(V_o - V_a)} \right\}^{\frac{1}{2}} \mu\text{F/cm}^2 \quad \ldots\ldots (3)$$

A graded or tapered junction requires a further modification of the above expression and:

$$C = 1{\cdot}05/4 \left\{ \frac{e^2 \cdot q \cdot G}{3\pi^2\,(V_o - V_a)} \right\}^{\frac{1}{2}} \mu F/\text{cm}^2 \quad \ldots (4)$$

where G is the gradient of $(N_a - N_d)$ in the transition region.

Expressions for step junctions differ from the above in that the capacitance is inversely proportional to the cube-root of the applied reverse voltage.

The Measurement of Junction Capacitance

Several methods can be used to determine diode junction capacitance. Nevertheless, the problem requires careful consideration of factors not met with in conventional 'metal plate' capacitance measurements. In measuring devices where alternating current is employed (potentiometric or bridge systems) the disymmetry in the forward and reverse passage states of the diode will modify the sinusoidal current waveform. The resultant inaccuracy of the reading is then directly related to the peak amplitude of the a.c.

When the diode conducts in the forward direction, free passage is allowed for one half cycle. The final amplitude in this direction depends on the portion of the forward characteristics utilized. In the reverse sense, the device will only conduct by virtue of its inherent junction capacitance and its leakage. Capacitance is again a function of the amplitude of the appropriate half cycle of the waveform. Over the half cycle:

$$V = A \sin \omega t \quad \ldots\ldots\ldots\ldots (5)$$

$$C = B/(V + k) \quad \ldots\ldots\ldots\ldots (6)$$

* *G. & E. Bradley Ltd (subsidiary of Joseph Lucas (Industries) Ltd).*

From equations (5) and (6):

$$B/C - k = A \sin \omega t$$

or

$$C = \frac{B}{A \sin \omega t + k}$$

At any instant then:

$$dC/dt = \frac{-B \cdot A \cdot \omega \cos \omega t}{(A \sin \omega t + k)^2} \quad \ldots\ldots\ldots (7)$$

where C = junction capacitance,

V = voltage at any point on the sine waveform,

A = the peak amplitude.

Without further analysis of this complex condition, it can be appreciated that the current waveform out of the rectifier under measurement, will no longer be sinusoidal. It is therefore necessary to choose the a.c. frequency to lie well beyond the frequencies at which the diode will behave as a rectifier. Furthermore, the device must be reverse biased by a direct voltage several times the peak amplitude of the alternating voltage employed, to minimize the type of fluctuation outlined above.

The capacitance at any particular reverse bias voltage can be calculated from the relationship.

$$C_{req} = \frac{1{\cdot}286K}{[V + 0{\cdot}71 - 0{\cdot}0022T]^{\frac{1}{2}}} \quad \ldots\ldots (8)$$

where K = the capacitance at -1V. [25°C ambient]

V = the reverse bias voltage.

T = the temperature in degrees centigrade.

A method of measuring junction capacitance, providing a high degree of inherent accuracy, allows the diode to act as the capacitive element in a tank circuit.

The resonant frequency is viewed on a counter or can be discriminated and read off on a valve-voltmeter. Several forms of this system are possible. The inductor can be made variable to provide a fixed frequency. This may be compared with a crystal controlled standard incorporated in the equipment. The inductance can then be measured by a bridge calibrated directly in terms of capacitance.

An r.f. bridge also provides a means of measuring junction capacitance with reasonable accuracy. It has the added dual advantages of economy and simplicity of operation. Commercial bridges depending on the transformer ratio arms principle are not easy to use in this application. It is difficult to balance out the resistive component in a diode and in many such instruments, primarily designed to measure pure capacitance or inductance, co-ordination cannot be achieved.

D.C. methods may lend themselves where large junction area, heavy duty rectifiers are concerned. Two methods are suggested. In the first, a charge is delivered for a small period of time, an accurate signal being provided to measure this interval. The diode is appropriately reverse biased to annul the effects of the voltage-capacitance variation due to its own charge. A ballistic galvanometer may then be used to measure the charge stored over the given period and the capacitance evaluated therefrom. The second method makes use of the smoothing action of a capacitor. Rectified a.c. is applied across a reverse biased diode and the smoothed d.c. component dependent on junction capacitance is measured. A valve-voltmeter device which can discriminate between pulsed and continuous d.c. must be used for this purpose.

In general, however, a.c. methods are far preferable to the d.c. systems outlined as they allow greater accuracy in measurement and flexibility in design.

Q and Leakage

The main source of loss in a 'diode capacitor' is its reverse leakage current. Being a function of the applied reverse voltage, its value increases with the control voltage —the smaller the effective capacitance, the greater the loss.

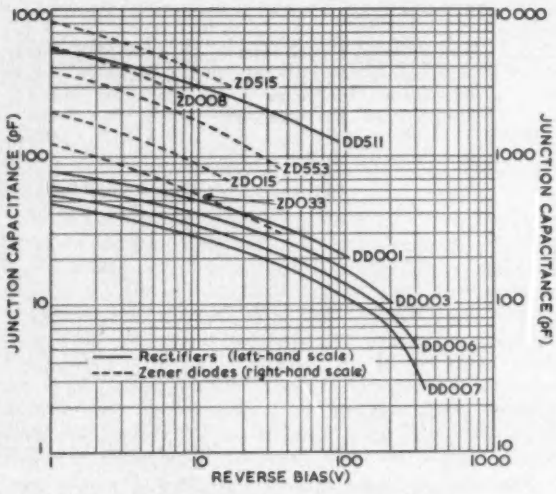


Fig. 2. Typical junction capacitance-reverse bias curves

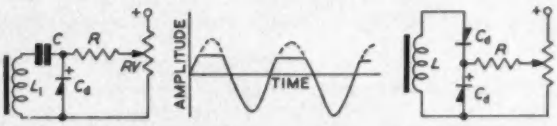


Fig. 3. (left) A simple resonant circuit with a silicon diode as the variable element

Fig. 4. (centre) Unsymmetrical clipping of a sine waveform in a single diode tuned resonant circuit

Fig. 5. (right) A simple resonant circuit using two diodes in series opposition

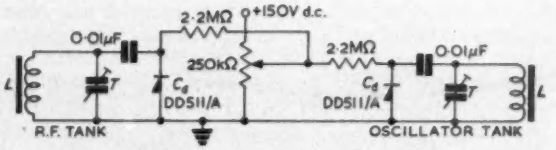


Fig. 6. Ganged diodes used to tune the resonant circuits in a superhet receiver

Silicon junction diodes are characterized by their low leakage currents which are usually of the order of milli-microamperes. In consequence, fairly high Q's are achieved. The series resistance, illustrated in the equivalent circuit of Fig. 1, is low whereas the shunt or edge leakage is normally high. However, edge losses increase with frequency, decreasing the Q. At lower frequencies, the efficiency of a diode as a capacitor falls due to its conduction in the forward direction. This factor also lowers the effective Q. Furthermore, junction capacitance and reverse leakage are both a function of temperature and are thus affected by ambient conditions. However, silicon

TABLE 1

TYPE	ZD533	DD511	ZD033	DD001
Junction Cap. (−1V) (pF)	3750	550	1250	84
Min. Junction Cap. (pF)	915	73	300	12
Max. Rev. Bias (V)	30	154	30	100

devices are less prone to parameter fluctuations with temperature than devices using other semiconductor materials and will function in many circuits as well as metal plate capacitors.

A variety of Lucas silicon diodes were measured. They all followed the same capacitance-reverse voltage law. In any particular family of rectifiers, i.e. diodes with the same current but different p.i.v. ratings, the maximum inherent junction capacitance varied inversely with the rated p.i.v. Zener diodes followed the same law although the maximum junction capacitance of these devices far exceeded that of rectifiers with the same physical dimensions.

Table 1 shows examples of averaged comparative values.

in general. As control elements they are usually paralleled with conventional capacitors in reactance modulator, a.f.c. and adjustable band-pass filter circuits.

Resonant Circuits

Fig. 3 illustrates the manner in which a diode may be used in a simple resonant circuit. Tuning is achieved by variation of the reverse bias, the magnitude being dependent upon the position of the slider of potentiometer *RV*. The capacitor *C* isolates the inductance from the d.c. supply, whereas resistor *R* serves to isolate the tuned circuit from the rest of the network. In practice the value of *R* can be several megohms as the reverse current through the diode is a few millimicroamperes. *R* will also protect the diode by limiting the current should the p.i.v. rating be exceeded.

Although this simple circuit will function, it has one major drawback. Owing to a process of self-biasing which in turn varies the junction capacitance, a sine wave is unsymmetrically clipped as shown in Fig. 4. When the signal is

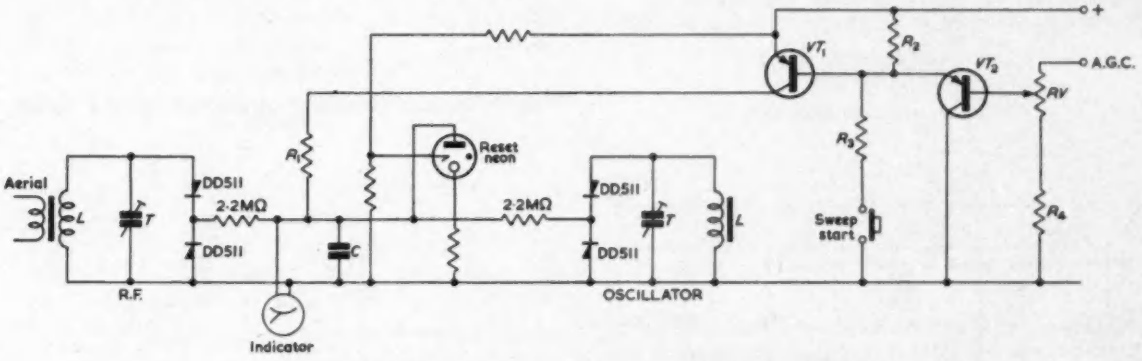


Fig. 7. Circuit showing how automatic sweep over a band may be achieved

Although hole storage effects curtail the usefulness of a rectifier in the forward direction, junction diodes as capacitors have been known to perform well up to 1 000Mc/s.

Applications

Semiconductor junction capacitors open up a new vista in electronic equipment design and have established themselves as useful circuit elements. They have an overwhelming advantage over their mechanical counterparts where equipment is subjected to vibration and the conservation of space is of importance. At present their uses fall into two broad categories—tuning and control. As tuning devices, silicon capacitors supply all or nearly all of the capacitance required by transmitter-receiver tuning circuits

TABLE 2

Frequency Band Coverage Obtained in a Superhet Receiver with Normal Metal Plate Capacitor Tuning and Ganged Diode Tuning

WAVE BAND	BANDSPREAD		OSC. VOLTAGE ACROSS INDUCTOR (Vr.m.s.)
	WITH METAL PLATE CAPACITOR	WITH LUCAS DD511's	
Short wave	6·3Mc/s—21·2Mc/s	6·3Mc/s—14·5Mc/s	0—5
Medium wave	480kc/s—1·74Mc/s	480kc/s—1·25Mc/s	18—25
Long wave	132kc/s—480kc/s	225kc/s—330kc/s	12—21

modulated as in the r.f. stages of a receiver, the distortion takes on a complex form.

This disadvantage may be overcome by the use of two diodes connected in series opposition (Fig. 5.)

The use of a d.c. blocking capacitor is unnecessary.

To see what could be achieved by direct substitution of two Lucas diodes for a conventional ganged capacitor, a commercial radio receiver was modified to the extent shown in Fig. 6.

Lucas DD511/A diodes were mounted directly on the chassis and connected in place of the usual tuning capacitor. A 250kΩ potentiometer was used as a manual tuning control and provided a means of varying the bias on both the oscillator and r.f. sections. The coils were left unaltered and the original trimmers helped to align the tank circuits.

TABLE 3

Output Levels Measured prior to Detection in a Superhet Receiver with Normal Metal Plate Capacitor Tuning and Ganged Diode Tuning

WAVE BAND	SIGNAL FREQUENCY	OUTPUT LEVELS	
		WITH LUCAS DD511's (V)	WITH METAL PLATE CAPACITORS (V)
Short wave	10Mc/s	0·9	0·05
Medium wave	1Mc/s	0·26	0·16
Long wave	300kc/s	1·2	1·5

Comparative figures of performance are given in Table 2.

Table 3 gives an indication of the signal levels measured at the last i.f. stage, prior to detection. The input signal amplitude was held constant and the a.v.c. network was disconnected for the purpose of this measurement.

It must be stressed that the foregoing experiment aimed at simplicity and no attempt was made to redesign the original inductors in the receiver. Using only one diode per section a certain amount of intermodulation distortion was present, especially on the short wave band. Drift, due to a temperature gradient over the face of the chassis, coupled with self-biasing effects, made tracking difficult at the higher frequencies. However, the performance was not unduly affected in this simple arrangement and was, in fact, more encouraging than purely theoretical considerations might lead one to expect. A revised specification for

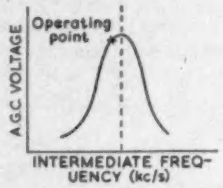


Fig. 8. A.G.C. frequency curve

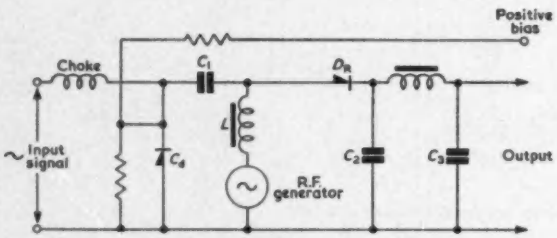


Fig. 9. A simple dielectric amplifier

the coils, together with the use of two diodes 'back to back' in each section, would achieve compatible results.

Remote Tuning Control

The basic idea of being able to control at the end of a long cable simplifies the design and installation of remote tuning systems. Normal practice, with its inherent complexity is plagued with the problem of having to deal with several or split r.f. stages. With diodes used as tuning elements, the equipment can be centralized and any number of switched remote control points may be provided. It is simply a question of running the requisite length of leads with potentiometers at their termination. This is often a great advantage in hotels, boats, and cars where it is convenient to place a receiver or similar device at a distance from the operator.

Automatic Tuning

Automatic sweep over a band can be accomplished without the use of complex electromechanical servomechanisms. The principle may be seen from a reference to the basic circuit of Fig. 3. Since tuning is achieved by the variation of reverse bias across the diode, the value of capacitor C can be chosen such that it charges up to the full line or required maximum voltage over a span of time. The voltage across the capacitor also appears across the diode, continuously varying the resonant frequency of the tank circuit.

The required band is thus swept over a period dependent on the time-constant CR. The capacitor can then be short-circuited down to earth, the charging cycle commencing again. In practice the switch is either a neon which triggers at the appropriate voltage or a 'snap action' relay. In a radio receiver, this action by itself is not of any consequence unless the charging of the capacitor can be interrupted on receipt of a signal. Fig. 7 shows how this may be achieved.

The tuned circuits are a combination of those shown in

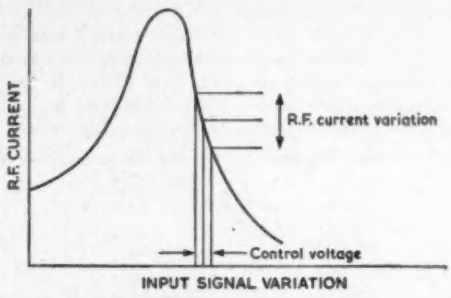


Fig. 10. Graphical illustration of the gain mechanism in a dielectric amplifier

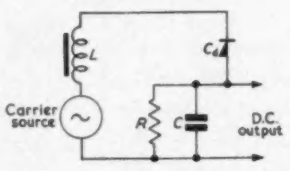


Fig. 11 (left) A carrier energized bistable circuit

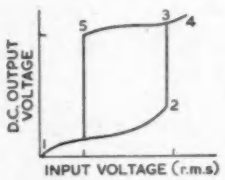


Fig. 12. (right) Output-input voltage characteristics of a carrier energized bistable circuit

Figs. 5 and 6. Capacitor C charges through resistor R_1 and provides the necessary reverse bias. The current through R_1 is controlled by the on/off state of transistor VT_1. When the set is switched on, transistor VT_2 being normally forward biased through resistor R_4 and potentiometer RV conducts, with a consequent potential difference across R_2. This in turn switches on transistor VT_1 and allows capacitor C to charge through resistor R_1. On receipt of a signal, the positive going a.g.c. cuts off VT_2, and VT_1 stops conducting owing to the lack of forward bias on its base. Although C will tend to discharge slowly through the finite circuit resistance, drift off the centre frequency will lower the a.g.c. voltage, allowing capacitor C to charge up again. The operating point is thus maintained in equilibrium as illustrated by the a.g.c.-frequency curve of Fig. 8.

If the station received is undesirable, a temporary closure of the reset switch will complete the biasing chain R_2R_3, and allow VT_1 to conduct. The voltage across C increases and the signal will no longer tune in. The a.g.c. voltage falls, allowing VT_2 to carry on forward biasing VT_1. As the next signal is received, the device will lock-on again. When the band is swept completely, the reset switch in the form of a triggered neon, fires, discharging capacitor C. The whole process is then repeated. The scale or indicator on the receiver can take the form of a cheap voltmeter connected across C. The potentiometer RV pro-

vides an effective sensitivity control, allowing signal levels well above the general noise threshold, to lock-on[4].

Dielectric Amplifiers

Dielectric amplifiers depend for their operation on the amplitude modulation of an r.f. signal with subsequent demodulation and filtering. Voltage gain is achieved by the use of resonant circuits. A simple amplifier configuration is shown in Fig. 9.

The mechanism of gain can be understood from the curve given in Fig. 10.

It is obvious that the voltage gain is a function of the slope of the 'tuning curve'. The circuit derives its name from the use of voltage dependent dielectrics. The use of silicon diode capacitors here results in considerable simplification of the circuit coupled with a higher degree of control. A high Q can be achieved and a silicon diode will give a large capacitance swing from a small inverse voltage change.

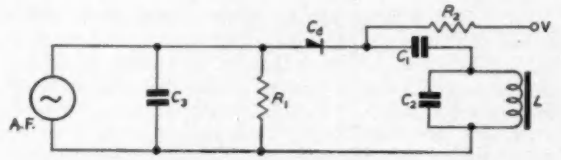


Fig. 13. A method of frequency modulation suitable for small transmitters

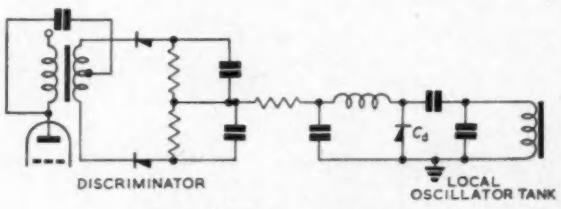


Fig. 14. Typical a.f.c. network

Pulse Circuits

A carrier energized bistable circuit is shown in Fig. 11.

L and C_d form a series resonant circuit, driven by a h.f. source. Both the variable junction capacitance and the non-linear conductance characteristics of the diode are utilized in this application. The effective capacitance of the diode depends on the amplitude of the d.c. and a.c. components across it. The d.c. component after rectification is essentially equal to the peak a.c. applied to the capacitor which in turn is dependent on the frequency and amplitude of carrier source voltage. The circuit may be tuned through resonance by varying the amplitude or frequency of the source. If the Q exceeds a certain minimum value, the change in output voltage will be abrupt. Fig. 12 shows the relationship between the d.c. output voltage and the r.m.s. input voltage.

Triggering can be accomplished by momentarily changing the input voltage beyond the critical amplitudes or by altering the frequency. The switching time achieved with a carrier of 2Mc/s is 2μsec. The silicon diode capacitor can also be used to vary the pulse width in free running blocking oscillators and monostable multivibrators.

Frequency Modulation

A silicon diode is an ideal substitute for complex reactance modulators in f.m. transmitters (Fig. 13). Its negligible power requirements (effectively set by the reverse leakage current) and small physical dimensions, make it ideal for this application in miniature f.m. transmitters.

In Fig. 13 the a.f. voltage appearing across R_1 varies the capacitance of C_d. This, in turn, changes the resonant frequency of LC_2. The biasing voltage V sets the centre frequency while C_3 acts as an r.f. by-pass. C_1 serves to block the d.c. biasing voltage from the tank circuit. A variation on this theme is shown in Fig. 14, where the silicon diode capacitor is used in an a.f.c. system typical in f.m. receivers[5].

Any drift in the frequency of the local oscillator results in a steady voltage from the discriminator. After filtering, this voltage varies the bias across C_d and so corrects the drift.

Straightening of Time-Constant Curve

Perhaps the most unusual use of a silicon capacitor is in straightening the time-constant curve of a waveform generator.

This is especially useful in ramp function generators where linearity of the curve is of prime importance. Fig. 15 shows an OC44 transistor used in the avalanche mode as a generator of fast pulses. A DD511 diode is connected in place of the normal capacitor. The diode tends to linearize the normal exponential charging curve by virtue of its increasing self-bias with charge. This factor can be of value in the design of time-base generators and associated circuits.

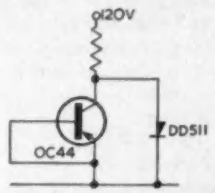


Fig. 15. A 'diode capacitor' tends to linearize ramp waveforms

Conclusion

Several additional fields of applications lie in RC oscillators, electronically controlled filters, radar and frequency multiplication[6,7]. It must be fairly stated that although silicon junction diodes as capacitors provide an interesting circuit element, the temperature dependence of capacitance is a serious handicap. However, with careful consideration and design, many standard circuits can be simplified by its use and no doubt several new configurations will come into being in the not too distant future.

Acknowledgment

The Author wishes to thank the Directors of G. & E. Bradley Ltd, for permission to publish this article.

REFERENCES

1. Biondi, F. J. (Editor). Transistor Technology. Vol. 2.
2. Lathrop, J. W., Lee, R. E., Phipps, C. H. Semiconductor Networks for Microelectronics. *Electronics 33*, 69 (13 May 1960).
3. Kilby J.S. Semiconductor Solid Circuits. *Electronics 32*, 110 (7 Aug. 1959).
4. Hammerslag, J. G. Signal Seeking Auto Radio Uses Semiconductor Tuning. *Electronics 33*, 60 (22 July 1960).
5. Gibson, S. K. Add A.F.C. with a Silicon Diode. *Electronics World*. (July 1959).
6. Brady, M. Oscillator Design Using Voltage Variable Capacitors. *Electronics 32*, 38 (21 Aug. 1959).
7. Petrak, J. R. A New Look at Wave Analyser Design. *Electronics 33*, 68 (23 Sept. 1960).

A Transistorized Pulse-Pattern Generator

By V. J. Phillips*, Ph.D., A.C.G.I., D.I.C., and G. M. Saltmarsh†

This article describes the design and construction of a pulse-pattern generator which produces repetitively a pattern of eight binary pulses in accordance with the settings of eight manually operated switches.

(Voir page 831 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 838)

THE pulse-pattern generator described in this article enables any particular sequence of eight digits to be generated repetitively in accordance with the setting of eight manual switches. The final output stage, which is designed to work into a resistive load of 120Ω, is a blocking oscillator, the output waveform of such a circuit being suitable for use in the circuits associated with the pattern-generator in this particular case. For other applications, of course, it might be convenient to replace this output stage by one which produces pulses of some other shape.

Principle of Operation

The block schematic diagram of the pattern generator is shown in Fig. 1, and the principle of operation is illustrated in Fig. 2. An ordinary signal generator is used to produce a sine wave having a frequency equal to the basic pulse repetition rate, which in this instance is 768kc/s, and this is used to operate a chain of three binary counters (divide by 8) in order to produce a square wave of frequency 96kc/s. A 96kc/s sine wave obtained by low-pass filtering this square wave is simultaneously applied to bridge phase-shift circuits producing eight outputs shifted in phase by 0°, 45°, 90° .... 315°. Each of these phase-shifted sine waves is then passed separately through a clipping circuit which removes all but the topmost portion of the sine wave producing the waveforms illustrated in Fig. 2(a) Each waveform consists of a series of rounded pulses whose time of occurrence relative to the other waveforms is determined by the settings of the phase-shift networks. These waveforms are then added together via switches S_1 to S_8 to produce a signal, the exact shape of which will be dependent on the settings of these switches. Fig. 2(b) shows an example of the type of waveform produced.

This waveform is then amplified in a direct-coupled amplifier and clipped in a Schmidt circuit to produce the rectangular signal of Fig. 2(c). This signal is used to gate some of the original 768kc/s sine wave, and after removal of the positive peaks the waveform of Fig. 2(d) results. In practice, it is necessary to insert a delay line or phase-shift circuit between the 768kc/s source and the gate in order to compensate for the delay produced in the counters, low-pass filter and other transistor circuits.

The gated sine wave of Fig. 2(d) is amplified and used to trigger a blocking-oscillator output stage, producing an output as shown in Fig. 2(e). It will be appreciated that by appropriate setting of the switches S_1 to S_8, any pattern of eight pulses can be generated.

Circuit Details

The circuit diagram of the pattern generator is shown in Fig. 3. The incoming 768kc/s sine wave, which needs to be approximately 1V peak-to-peak in amplitude, is first clipped in the circuit VT_1, VT_2, and is then passed to the three binary counters (VT_3, VT_8), which are of conventional form, and are each driven from the preceding stage by differentiating networks and diodes as shown. The output from the last binary stage is applied to the input of the low-pass filter via emitter-follower VT_9. The filter is of

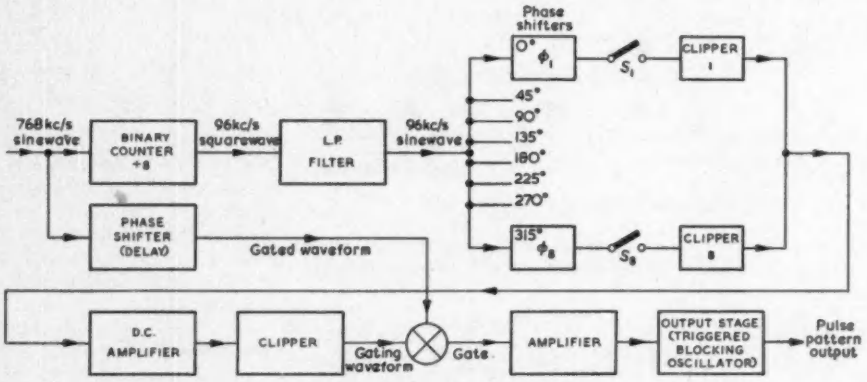
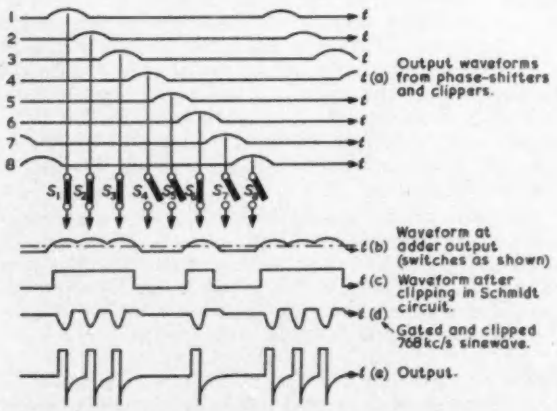


Fig. 1. Arrangement of the pattern generator

Fig. 2. The principle of operation



* University College of Swansea
† St. John's College, Cambridge

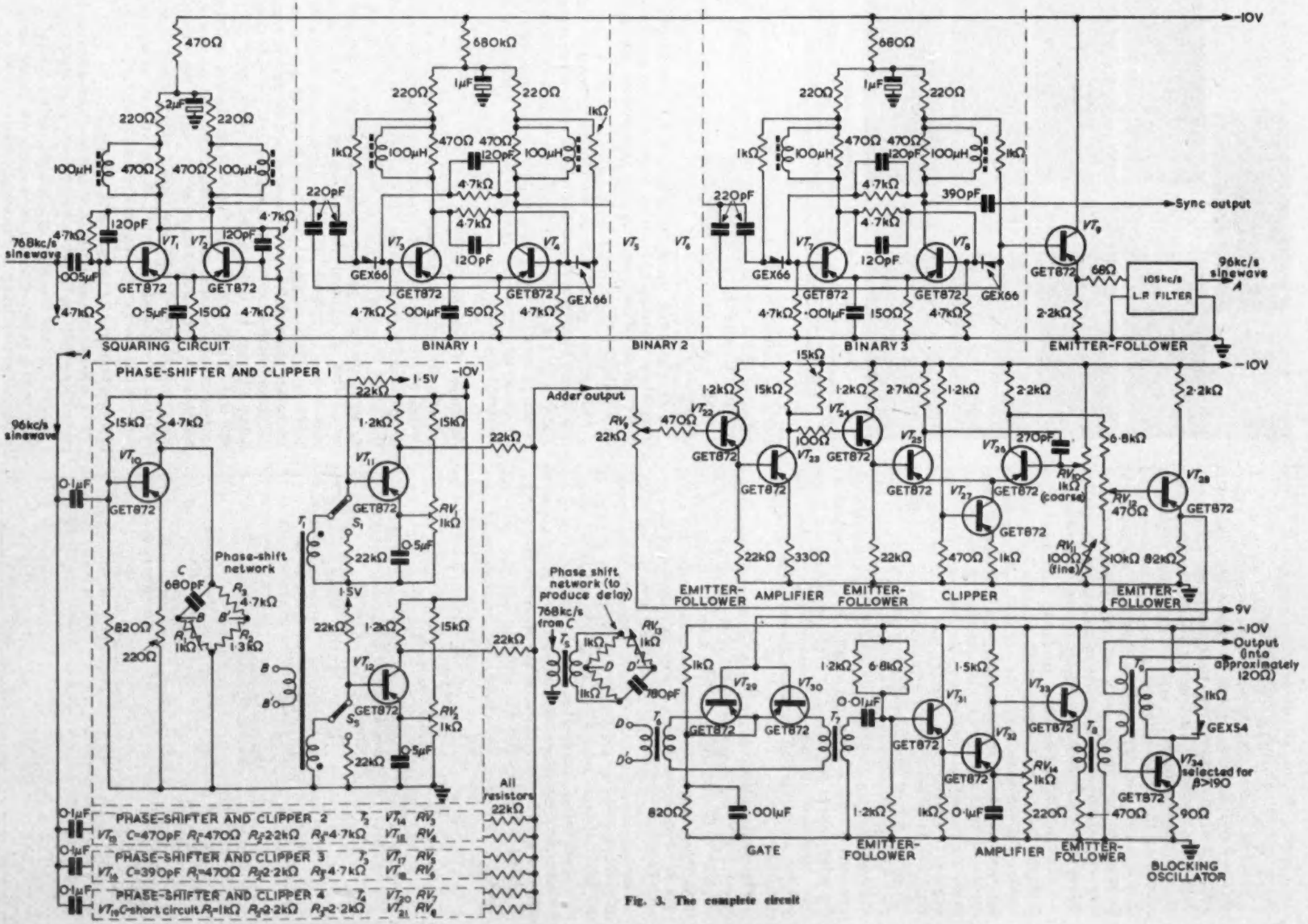


Fig. 3. The complete circuit

conventional design, consisting of a constant-K section and m-derived terminating half sections.

It will be realized that the waveforms produced by phase-shifters 1 and 5 of Fig. 1 are in antiphase (180° difference) and so it is only necessary to have one phase-shifting network with two output-windings on its transformer in order to produce waveforms 1 and 5. The same applies, of course, to the other antiphase pairs of waveforms, and thus it is only necessary to have a total of four networks to produce the required eight phases. Each network is driven by means of an amplifier stage, and the component values required in each network are shown in the diagram.

The outputs of the networks are fed to the clipper stages (VT_{11} to VT_{12}), the clipping levels of which are set by means of the potentiometers RV_1 to RV_8. The transistors are normally held non-conducting by the +1·5V bias supply so that only the extreme portions of the negative peaks are passed by the clippers. The switches S_1 to S_8 are single-pole, double throw switches, and it will be observed that when they are in the 'off' position a 22kΩ resistor is connected across the transformer winding. It was found that if the switches were merely open-circuited, the resulting impedance change was reflected back through the transformer and affected the amplitude of the signal on the other output winding. The 22kΩ resistors were therefore provided to act as 'dummy-loads' when the switches are in the 'off' position, thereby overcoming this difficulty.

The phase-shifted and clipped waveforms are added together and the resulting signal is amplified in the d.c. amplifier VT_{13} and clipped in the Schmidt circuit VT_{15} to VT_{17}. Preset control RV_9 varies the bias level on the signal applied to the Schmidt circuit and the panel-mounted controls RV_{10} and RV_{11} control the clipping level of the circuit.

The sine wave from the 768kc/s source is phase-shifted to produce delay as previously explained, and is gated in the two-transistor gate VT_{23}, VT_{25}. The resulting signal, after removal of the positive peaks in VT_{32} (adjusted by RV_{14}) is used to trigger the output stage VT_{34} which is designed to drive impedances in the range of 100 to 200Ω. It should be noted that the blocking oscillator will not trigger if incorrectly terminated. The panel-mounted control RV_{12} controls the d.c. bias on the signal applied to the gate, and RV_{13}, which is also on the panel, enables the amount of phase-shift to be adjusted.

TABLE 1

Details of Transformers

T_1, T_2, T_3, T_4 Phase-shifters	'Midget' Mumetal Laminations ·004 in. thick	Primary—200t Secondaries—200t each. Inductance of each winding ≃ 0·3H
T_5 Delay network	Ferroxcube A_4 core type FX1238	Primary—6t Secondary—10t
T_6 Gate input	Ferroxcube A_4 core type FX1238	Primary—18t Secondary—6t
T_7 Gate output	Ferroxcube A_4 core type FX1238	Primary—9t Secondary—7t
T_8 Blocking oscillator triggering	Ferroxcube A_4 core type FX1238	Primary—18t Secondary—6t
T_9 Blocking oscillator	Gealloy T core type C54	Collector winding—40t Base winding—24t Output winding—16t (Output winding screened from other two)

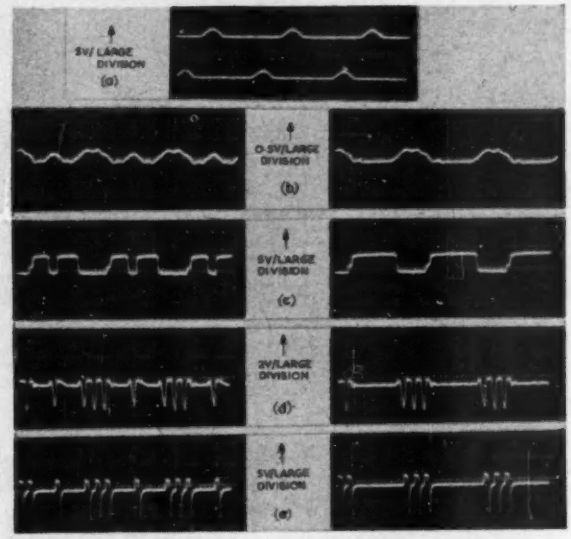


Fig. 4. Waveforms present in pattern generator

(a) Outputs from two of the phase-shifters and clippers; (b) Waveform at adaer output; (c) After clipping and inversion; (d) Gated and clipped 768kc/s sine wave; (e) Output-patterns 11100100 and 11100000

Table 1 gives details of the various transformers in the circuit.

A synchronizing signal from the third binary stage is available at a socket on the front panel, and this enables a stable picture of the groups of eight pulses to be displayed on a cathode-ray oscilloscope.

Photographs of the actual waveforms present in the circuit may be seen in Fig. 4, and these correspond to those sketched in Fig. 2. Fig. 4(a) shows the outputs from two of the phase-shift and clipper circuits, while Figs. 4(b) to (e) show the waveforms present for two patterns—viz. 11100100 and 11100000.

Alignment Procedure

(1) Adjustment of phase-shift circuits

One of the outputs of T_4 (transformer associated with the phase-shift circuit having the short-circuited capacitor) should be observed on a c.r.o. Switches S_1 to S_8 should be set in the 'off' position, and the R_1 of this phase-shift circuit (No. 4) adjusted until the output sine wave has a peak-to-peak amplitude of 0·6V. Then, using a double-beam c.r.o., this voltage should be observed on one beam. The other phase-shifted waveforms should be observed on the other beam in turn, the appropriate R_1 in each case being adjusted to produce the correct phase-shifts (45°, 90° or 135°). Notice that theoretically the output voltage from each phase-shift network should remain constant as the phase-shift is varied[1]. However, in practice the voltage does vary somewhat, and the circuit values have to be designed to produce an outut of the correct amplitude (0·6V in this case) at the required phase-shift setting.

(2) Adjustment of clippers (RV_1 to RV_8)

The collector of each clipper should be observed in turn on a c.r.o., and the preset potentiometer associated with the circuit should be set to produce waveforms similar to those shown in Fig. 4(a), the peak amplitude of the hump in the waveform being approximately 2V.

(3) ADJUSTMENT OF RV_9

Switches S_1 to S_8 should be set so as to produce some convenient on/off pattern at the output of the adding circuit. One of the collectors of the Schmidt clipper circuit VT_{25} to VT_{27} should be observed on a c.r.o. It will be found that the clipper operates satisfactorily over a fairly restricted range of setting of RV_9, and RV_9 should be set to approximately the centre of this range.

(4) ADJUSTMENT OF RV_{10} AND RV_{11}

RV_{10} and RV_{11} set the exact clipping level of the Schmidt circuit and should be adjusted until the correct waveform corresponding to the switch settings is produced at the collector of VT_{26}.

(5) ADJUSTMENT OF RV_{12}, RV_{13} AND RV_{14}

The waveform at the collector of VT_{32} should be observed, and RV_{12}, RV_{13} and RV_{14} adjusted until it is similar in form to that shown in Fig. 4(d). The output of the blocking oscillator should be observed and RV_{14} adjusted so that this stage triggers properly and produces the correct pulse pattern.

If at any time the panel-mounted controls are disturbed accidently it is not necessary to repeat all the above procedure. It will be found that correct operation is fairly easily achieved merely by readjustment of the controls while observing the output of the blocking oscillator.

Comments

It will be found when operating the pattern generator that the exact position of any pulse along the time axis tends to vary according to the presence or absence of the preceding pulse, and to a much smaller extent, the presence or absence of the pulse before that. This is a fundamental disadvantage of the blocking oscillator circuit and is due to incomplete tail discharge. It has not been found possible to remove this variation completely by changes in the blocking oscillator design. The variation in position is small, however, being of the order 0·1μsec in a pulse repetition period of 1·3μsec, and for the particular purpose for which the generator was required it was not at all serious.

If for any particular application pulse timing is of major importance, then an improvement may be effected by replacing the blocking oscillator by some other monostable circuit.

Acknowledgments

This work was carried out when the authors were at the Hirst Research Centre of the General Electric Company Ltd, Wembley, and the authors wish to thank the Directors of G.E.C. Ltd for permission to publish this article.

REFERENCE

1. EVEREST, F. A. Phase Shifting up to 360°. *Electronics*, *5*, 46 (Nov. 1941).

A Broadcasting Transmitter with Trapezoidal Modulation

Marconi's Wireless Telegraph Co. Ltd. are now producing a new 250kW h.f. sound broadcasting transmitter which embodies a number of new techniques. Known as the type BD272 it has a frequency range of 3·95 to 26·1Mc/s and the overall design aim has been to provide a highly efficient, reliable broadcast transmitter which requires the minimum of supervision.

Among the many important technical features are the following:

(1) Continuously variable control of the modulation from sine wave to trapezoidal; this feature enables the character of the transmission to be adjusted to the optimum condition for working through interference of a given degree of severity. Harmonic and spurious radiation is very low despite the trapezoidal character of the waveform. A built-in envelope monitor displays the outgoing modulated waveform.

(2) The use of wideband techniques in two of the three early r.f. stages and the penultimate r.f. amplifier cathode to eliminate tuning in those stages, and thus to simplify materially the process of changing frequency. Quick-release chuck-type coil holders are used to speed a coil-changing operation.

(3) The incorporation of a new system of vapour-cooling for the main valves which makes valve changing easier.

Brief details of the modulation and cooling systems are as follows:

THE MODULATION SYSTEM

While this transmitter can operate under conditions of conventional modulation, one of its special features is that it can be adjusted to provide a much higher average of modulation than is possible with normal design.

This has been achieved by arranging it to accept an audio signal of a level which is 9dB above that required for 100 per cent sine wave modulation and then clipping and shaping it in the audio input circuits to give 95 per cent modulation. The resultant output from the modulator is consequently no longer of sine wave aspect, but rather a pulse with sloping leading and trailing edges—a wave shape which is termed trapezoidal. The modulated carrier envelope is likewise no longer a sine wave.

Under these conditions it has been established that the intelligibility of the signal received at a distant point is increased at least 3·5dB above that produced by sine wave operation at equivalent output power.

Trapezoidal modulation cannot readily be incorporated in existing transmitters using conventional sine wave modulation; this, for various reasons. One of these is that the clipping process can introduce overshoot and tilt into the waveform at the modulation output; these effects tend to peak the modulation level beyond 100 per cent, with a consequent tripping of the transmitter.

This has been obviated in the BD 272 by the introduction of a phase-correcting network in the sub-modulator. The network intentionally introduces distortion into the 'trapezoidal' signal; this distortion, when it reaches the modulator output stage, is arranged to be equal in amplitude and opposite in phase to the overshoot and tilt produced at that point, thus nullifying it The intermediate amplifying stages and the subsequent cathode-follower must therefore be specially designed to handle with fidelity the intentionally distorted waveforms as these would overload a conventional modulator amplifier.

Furthermore, although a 'clean' signal is produced at the modulator output, the power content of the clipped wave is more than 1½ times that of a sine wave of equivalent modulation level, and as a consequence a modulator of increased power handling capacity has to be provided. The main h.t. rectifier (which supplies the main r.f. and modulator stages) must also be capable of delivering more power, for whereas with 100 per cent sine wave operation the audio power delivered to the modulated r.f. stage is 0·5 of the d.c. input to that stage, in the case of 95 per cent trapezoidal modulation the value increases to 0·768. Similarly, while the r.f. output with 100 per cent sine wave modulation equals 1·5 times the unmodulated carrier power, the figure for 95 per cent trapezoidal modulation is 1·768.

THE COOLING SYSTEM

The high-power valves are vapour-cooled and the smaller valves radiation-cooled, with an extractor fan drawing off the radiated heat from the cubicles.

The vapour cooling differs from that employed in the 100kW BD 253 transmitter which uses a 'vapour-up' system. The BD 272 employs a 'vapour-down' system, in which a high level tank provides a 'head' of water which is fed to the valve boilers. In the boiler or jacket is a 'weir' which keeps the water level constant. The heat generated by the valve passes into the water and produces the water-vapour; this, together with any over-spill of water from the weir, is taken through a relatively large bore pipe which slopes down to a low-level vapour separator tank. The vapour is then taken to a heat exchanger and the resulting condensate is pumped back as water to the high-level tank.

The use of this method enables various valves at differing height-levels to be fed from a common header tank, with the further advantage that the level in the individual valve boiler remains constant, while the space above the valve can be kept clear, making valve changing easier.

A Transistor 50W Audio Amplifier

By F. Butler, O.B.E., B.Sc., M.I.E.E., M.Brit.I.R.E.

The amplifier, which operates from a.c. mains, has an overall gain of 105dB and employs four power transistors in an output stage suitable for direct coupling to a 15Ω load. Low distortion is achieved by the use of mixed positive and negative feedback, the latter being applied over three push-pull stages. Where possible, direct interstage coupling is used to save components and to stabilize the transistor working conditions. Some equalization is provided in the low-level stages to give a level frequency response when the amplifier is used in conjunction with a v.h.f. radio tuner unit.

(Voir page 831 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 838)

THE design of a high-power, high-quality audio amplifier is a difficult exercise when using transistors, although the task is a little easier if a modest output is acceptable. For example, a 4W amplifier designed by P. J. Baxandall of the Royal Radar Establishment gives a performance comparable in all respects with the best valve amplifiers. A full description of this circuit has not so far been published, although the equipment has been shown at the Physical Society Exhibition, together with a circuit diagram and a note on the performance characteristics. In brief, a wide frequency response with low distortion was achieved by the use of power transistors with exceptionally high alpha cut-off frequencies, by using special interstage coupling techniques and by employing a very large amount of negative feedback. One major design problem was to provide this heavy degeneration while preserving an adequate margin of stability in respect of gain and phase-shift.

A fundamental difficulty in designing larger amplifiers stems from a basic defect of many present-day power transistors. This is the relatively low value of the cut-off frequency when the transistor is used in the common-emitter connexion. In all cases the current gain falls off progressively as the signal frequency is raised and for some samples the decrease becomes significant even at frequencies as low as 3kc/s. Worse still, the decrease in beta is accompanied by an excessive phase-shift which complicates the design of the feedback loop. At high audio frequencies a particularly objectionable form of distortion, traceable to hole-storage effects in the base region of the transistor, is also encountered and this is extremely difficult to correct. Finally, the base-to-emitter input impedance of a common-emitter power amplifier stage is decidedly non-linear and the current gain falls drastically at high signal levels. To combat these effects calls for some ingenuity in the design of the driver stage, but a satisfactory compromise is not too difficult to find[1].

It must not be assumed that power transistors of the future will always suffer from these disabilities. Indeed, the Bendix Company in the U.S.A. has introduced a range of diffused alloy power transistors which have much improved characteristics, but which are not yet competitive in price with the general run of high-power units of conventional types. For use in the entertainment field a power amplifier must be built around transistors which are readily available at an economic price. The design ought to be sufficiently flexible to permit the substitution of improved transistors without major modifications. This aim has been kept in mind in the equipment to be described.

The prototype was built some years ago, using a mixture of such transistors as were then available. Some have since been changed as superior types were introduced so that the present complement is an illogical selection. For this reason the descriptive text is concerned more with basic principles than with circuit details. Although component values are specified it must be realized that some changes will be required to suit transistors picked from a single manufacturer's range.

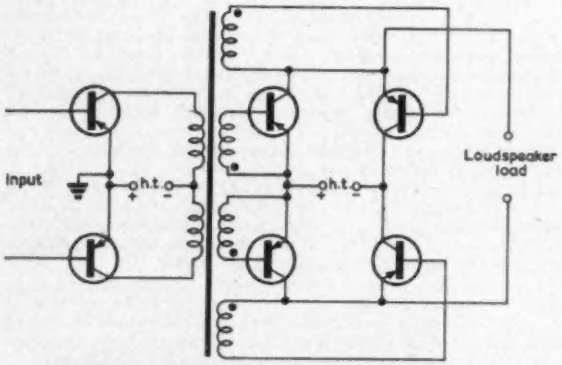


Fig. 1. Arrangement of the driver and output stage

Design Features and Objectives

A preliminary study of various power-transistor characteristics showed that a 50W amplifier could be built for little more than the cost of a 10W unit, the difference being due to the more expensive transformers and electrolytic capacitors in the larger power supply. An output stage in the form of a four-transistor bridge circuit was eventually chosen because it could be designed to feed directly a 15Ω loudspeaker combination. This saved the cost and weight of the output transformer required in a normal push-pull circuit and avoided the use of a very large shunt-feed electrolytic capacitor needed in a conventional transformerless output stage. Economically there is little to choose between the three possible arrangements but the bridge circuit has other advantages arising from its symmetry and balance.

Fig. 1 shows the principle of the bridge amplifier and

its push-pull driver stage. For simplicity, all bias networks have been omitted. Dots on the transformer secondary windings show the instantaneous polarities and it will be seen that diagonally opposite transistors of the output stage are driven in phase, thus causing the desired alternating current in the load. Using four Texas Instruments transistors type 2N458 in the output stage, and with a power supply of 2A at 50V, an output of over 50W is easily developed in a 15Ω load. This is far too much for use in an ordinary room, but it implies a low distortion figure at normal listening levels while overloading is virtually impossible.

A well-designed amplifier will stand a substantial amount of negative feedback over three tandem stages, particularly if these are all in a push-pull configuration. This mode of connexion has another practical advantage in mains-operated equipment. Here there is considerable risk of hum feedback from the output to the input stage due to poorly filtered power supplies. The inherent good balance of push-pull circuits will minimize the resulting degradation of signal-to-noise ratio. Another useful feature is that a cross-neutralizing technique may be used to offset the Miller effect which is responsible for some reduction of high-frequency gain of transistor amplifiers.

In practice, so much negative feedback can be employed that even the first stage of a three-stage amplifier becomes hard to drive. If series feedback alone is used to provide a high input impedance, then a high-amplitude drive voltage is required. Conversely, shunt feedback gives a low input impedance but requires a substantial drive current. A mixture of series and shunt feedback gives an acceptable compromise which allows the input impedance to be set at some convenient figure matching the output impedance of the driver stage. It is also of value to use positive feedback over one or more intermediate stages of a multistage amplifier which has overall negative feedback. If used over one stage, positive feedback will reduce the input drive requirements without provoking instability.

Loudspeaker loads are reactive at all but a few isolated frequencies and in the interests of stability it is worth attempting to compensate for this at the high-frequency end of the range. This can be done by converting the speaker impedance into a constant-resistance network by the use of passive components in series or parallel with it. If, for example, over some high-frequency range the loudspeaker simulates a resistance R in series with an inductance L, the connexion across its terminals of a resistance R in series with a capacitance C will turn the network into an equivalent pure resistance R, provided only that $L = CR^2$. Compensation will only hold over the frequency range for which the loudspeaker is representable by fixed elements R and L.

Before discussing some actual amplifier circuits incorporating these principles some reference may be made to the advantages of direct coupling between transistor stages. There is a worth-while saving of components, bias stabilization can be achieved and there is an improvement in the phase characteristic of the amplifier due to the elimination of coupling capacitors. Against this, d.c. coupling calls for a rather careful selection of resistance values in order to establish the correct operating points of all the coupled transistors. In spite of this last disadvantage, considerable use has been made of the technique in both audio and video-frequency amplifiers.

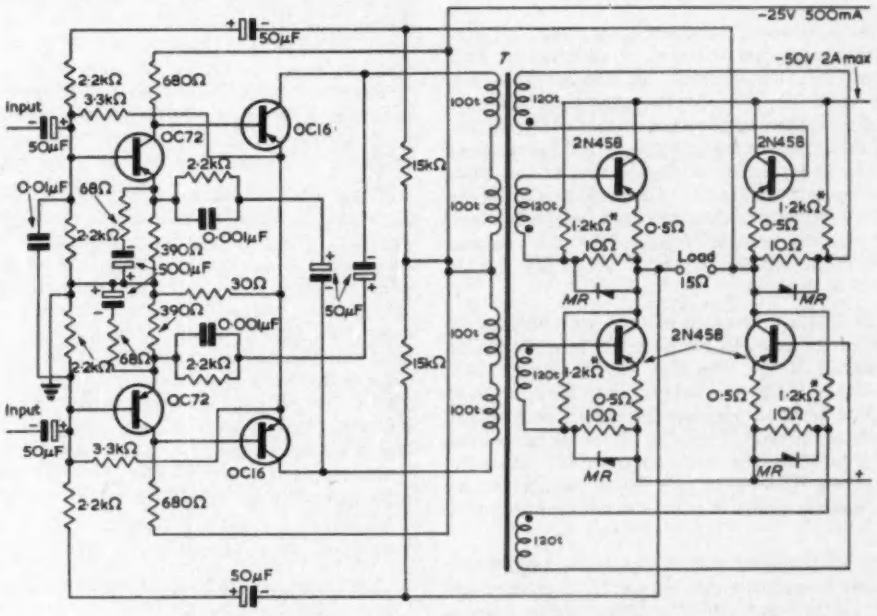


Fig. 2. Complete circuit of driver and output stage

Practical Amplifier Circuits

Fig. 2 is the complete circuit diagram of a three-stage amplifier which embodies most of the ideas just described. The multiplicity of feedback elements gives it an appearance of extreme complexity, although it can be dissected into simple arrangements with which many readers will already be familiar. Dealing first with the output stage, this differs only from Fig. 1 by the inclusion of base bias

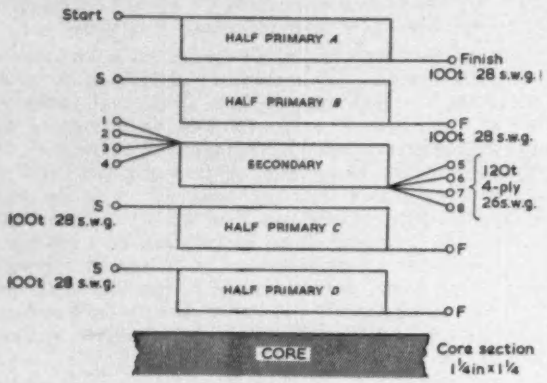


Fig. 3. Winding sequence for driver transformer

components. A germanium junction diode *MR* is connected in parallel with the 10Ω arm of each of the four bias potential-dividers. These diodes are not strictly necessary but they tend to stabilize the quiescent collector currents of the transistors in the face of large temperature changes. They do so because their forward resistance varies with temperature in a manner similar to that of the base-emitter diodes of the transistors. Each diode should be mounted on the same heat sink as the associated transistor, but must be electrically insulated from it. The mean current rating of each diode should be about 0·5A; the B.T.-H unit type GJ3-M is suitable.

The four 1·2kΩ bias resistances marked with an asterisk must be adjusted by trial to equalize all four transistor currents and voltage drops. The best way of doing this is to use an auxiliary 25V power supply and check the four transistors individually, varying the bias until each draws the same standing current. There is no point in biasing back to give true class-*B* conditions since the quiescent power consumption is unimportant. Better results can be achieved by class-*AB* working with a standing current of about 125mA.

Turning now to the front end of the main amplifier it will be seen that a matched pair of OC72 transistors are direct-coupled to push-pull OC16's. These latter have a relatively high resistance, (30Ω), in the common emitter lead. This tends to equalize the output from each OC16 and also develops a direct p.d. which is used to provide stabilized bias to each OC72 through a 3·3kΩ resistor. The standing collector current of each OC16 is set at 250mA, ensuring strict class-*A* operation.

The driver transformer *T* is designed to have a low leakage reactance, achieved at the expense of rather large inter-winding capacitances. These are tolerable because of the low source and load impedances between which the transformer works. The cross-sectional area of the core should be about 1¼in² and the window area no larger than that required to accommodate the windings and the necessary insulation. Four identical secondary windings are required and close magnetic coupling is ensured by winding them in a four-ply form, starting and finishing ends being brought out to a suitable tag board. Each half-primary is wound in two sections, one inside and one outside the secondary group. The precise winding sequence will be apparent from a study of Fig. 3. The four primary sections are all connected series-aiding, but in such a way that each half-primary is split so as to sandwich the complete secondary winding. A centre-tap is brought out for the negative h.t. connexion and the two free ends of the primary winding are wired to suitable terminal tags.

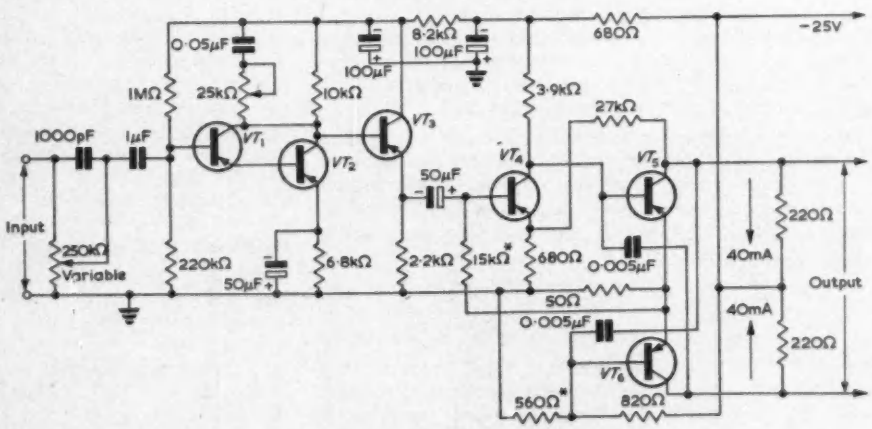
Returning to Fig. 2, overall negative feedback from the output stage is taken to the base of each input transistor through a 50μF capacitor and a resistance of 2·2kΩ. Polarizing bias to the 50μF electrolytics is supplied from the negative end of the 25V supply through two 15kΩ resistors. Some local positive feedback is applied through two *CR* networks (each with 2·2kΩ in parallel with 0·001μF), from the OC16 collectors to the OC72 emitters. In order to stabilize the collector current of each OC72 transistor, a relatively high emitter resistor of 390Ω is used. To restrict the amount of negative feedback, this resistance is shunted by 500μF in series with 68Ω.

If used with the input on open-circuit the amplifier may be found unstable. In practice it is driven from a pre-amplifier of which the output impedance forms an essential element in the feedback path. The overall voltage gain from the OC72 bases to the 15Ω load is about 50. An output of 60W, corresponding to 30V r.m.s. across the 15Ω load, calls for an input, (base-to-base), of 0·6V. Tests show that the frequency response of this part of the circuit is flat from 20c/s to 7kc/s, falling slowly to 4dB down at 10kc/s. The output impedance is virtually zero since there is no detectable change in load voltage as the load impedance is changed from 15 to 20Ω. Hum and noise are almost inaudible, being lower in level than the slight mechanical noise generated by transformer and choke vibration.

Aluminium plates are used as heat sinks for all the transistors, their dimensions in inches being as follows:

2N458	OC16	OC72
4×4×¼	3½×3½×¼	2½×2½×16 s.w.g.

Fig. 4. Pre-amplifier and phase-splitter



Pre-Amplifier and Phase-Splitter

Six transistors are used in this part of the circuit, shown in Fig. 4. Two power transistors VT_5 and VT_6 are used in the final stage to give a push-pull drive to the main amplifier. An essential design requirement is that the output impedance of this stage must be such as to give the right amount of negative feedback in the main amplifier. If, for example, the output impedance of the driver were zero there would be no feedback. At the other extreme, a very high output impedance would give so much feedback that stability could not be maintained. Furthermore, the requisite drive power would be excessive. With fair accuracy the main amplifier may be regarded as one of the 'virtual earth' variety. Here a phase-reversing amplifier of internal gain A is supplied from a source E_1 in series with a resistance R_1 developing an output voltage E_o across the load. A feedback resistance R_2 is connected between input and output of the amplifier. If A is very large the voltage gain E_o/E_1 is closely equal to R_2/R_1 and is almost independent of the actual amplifier characteristics. The input impedance is R_2/A and for the circuit of Fig. 2 is around 44Ω.

Turning again to Fig. 4, phase-splitting in the output stage is achieved by the use of a 50Ω resistance in the common emitter lead of VT_5 and VT_6. There is an analogous valve circuit of this type which has not been widely used with transistors. It will be seen that VT_5 is driven directly from an intermediate power transistor VT_4 while VT_6 is operated in the grounded-base mode. In fact the base of VT_6 is not grounded directly but through the 560Ω component of the bias potential-divider of which the other arm is 820Ω. In this way the external base-to-earth impedance of VT_6 is brought more nearly equal to that of VT_5 than it would be if the base of VT_6 were grounded directly or through a very large capacitance.

Stabilized bias for VT_4 is taken through a 15kΩ resistor from the negative end of the 50Ω resistor and some negative feedback from VT_5 to VT_4 is provided by the connexion of a 27kΩ resistor as shown.

Patient adjustment of the components marked with an asterisk is required to give the right standing current in VT_4 and equal collector currents, about 40mA each, in VT_5 and VT_6. Cross-neutralizing capacitors, (0·005μF), are used to give some increased high-frequency gain from the output transistors.

At the input end, VT_1 and VT_2 form a super-alpha pair feeding an emitter-follower VT_3. This arrangement was used because the pre-amplifier was required to have a high input impedance for connexion to the discriminator of a conventional v.h.f. tuner. Some (variable) bass-lift is provided by a 0·05μF capacitor in series with a 25kΩ variable resistor, shunting the collector load of VT_2. The degree of correction normally required calls for a resistance setting around 8kΩ. To equalize the high-frequency response a capacitor of 0·001μF is connected in parallel with the upper arm of the input gain control. At low settings of this control an excessive correction is provided, which suits low-level listening conditions. At higher volume levels the treble-accentuation is automatically reduced to avoid overloading the high frequency loudspeaker. Due to the particular loudspeakers actually used the most natural reproduction calls for a moderate attenuation of high frequencies.

The overall gain of the pre-amplifier and main amplifier is more than 105dB. With the input gain control at maximum the measured input impedance is 60kΩ and the input signal required to give 60W output at 1 000c/s is 10mV. With this combination of high gain and high input impedance, first stage transistor noise is objectionable. A simple cure for this would be to fit a valve cathode-follower after the discriminator stage of the radio tuner and to remove the transistor VT_1. A normal bias network on VT_2 would then be required. There would be a substantial improvement in the overall signal-to-noise ratio and a figure better than 60dB should be attainable.

The amount of high and low-frequency equalization provided is only sufficient to cope with radio programmes, but there is no particular difficulty in extending the range to suit a variety of tape or disk recording characteristics.

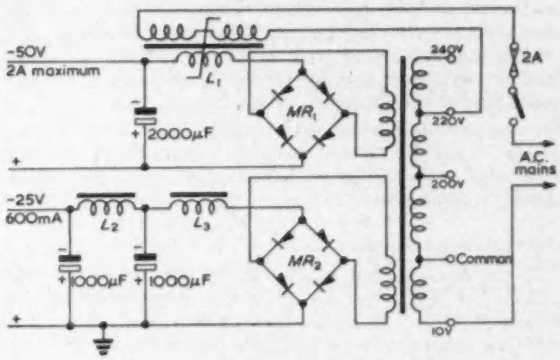


Fig. 5. Power supply unit with saturable-core reactor

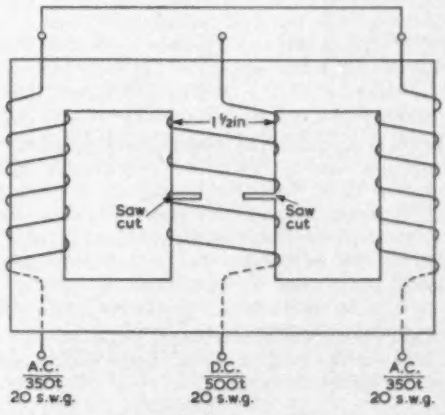


Fig. 6. Saturable-core reactor

Transistor types used in the amplifier are as follows:

VT_1	General Electric	GET6	low noise types.
VT_2	„ „	GET6	
VT_3	Mullard	OC72	
VT_4	Newmarket	V15/20IP	
VT_5	„	V30/30P	
VT_6	„	V30/30P	

Power Supply Unit

The arrangement used is shown in Fig. 5. A single power transformer carries two secondary windings. These supply bridge rectifiers MR_1 and MR_2 giving smoothed d.c. outputs of 50V 2A and 25V 600mA respectively. Suitable silicon bridge rectifiers are available from G. and E. Bradley Ltd. The 25V supply employs an input choke filter followed by a further stage of smoothing. The induct-

ances L_1 and L_2 are non-critical in value but their d.c. resistances should not exceed a few ohms. In the 50V supply a saturable core reactor is used to provide a measure of voltage regulation in respect of load current changes. The specification is given in Fig. 6. The saw-cut in the square-section centre limb of the core avoids any possibility of magnetic saturation at d.c. levels below about 2A. The d.c. coil wound on the centre limb carries the amplifier load current and acts as a filter choke. An increase in current partially saturates the core and reduces the reactance of the a.c. windings. These are connected in series-opposition so as to cancel induced voltages from the centre coil and the pair acts as a choke in one leg of the mains supply to the power transformer primary. The changing reactance of this choke caused by d.c. load current variations can be made to give close voltage regulation of the final d.c. output.

Although this arrangement is actually used in the present amplifier it is scarcely worth fitting because modern rectifiers give sufficiently close regulation without special compensation.

Constructional Details

In the prototype equipment the power supply unit was included in the same box as the rest of the amplifier and it proved difficult to reduce hum to an acceptable level. A two-unit construction is therefore recommended with the power supply unit built into a separate compartment. Still greater flexibility from the point of view of installation, servicing and operation would be achieved by separating the equipment into three functional blocks. Of these, the first might include the pre-amplifier with its various controls. The second would consist of the main amplifier with its driver stages while the third would include the power supply components, mounted in a well-ventilated enclosure.

In the main amplifier the transistor cooling plates should be mounted on the outside of the chassis and might well be shaped to form the enclosure for the remaining components. The heat sinks must be electrically insulated from the chassis and from each other and care must be taken to avoid the risk of contact with any earthed metalwork of adjacent units. Free air circulation is essential if the amplifier is to be used under high temperature conditions.

As regards the pre-amplifier stages some care in physical layout is necessary because of the high overall gain. The main points calling for attention are:

(a) Physical separation of high power stages from the low level input stage.

(b) Avoidance of wiring loops of large area in the low level stages which would pick up hum by induction from the power supply unit.

(c) Careful choice of grounding points and, in particular, avoidance of multiple earthing points.

(d) Use of an electrostatic screen between primary and secondary windings of the power transformer.

Normally there is no necessity to use screened leads in any part of the amplifier, but it is desirable to use tinned copper braiding over the interconnecting cables between the various units and between the microphone, pick-up, or radio feeder unit and the audio amplifier itself.

Amplifier Performance

Salient characteristics of the amplifier are as follows:

Rated Power Output: 50W

Power Gain: 105dB

Frequency Response:

(a) No equalization:

Level from 500c/s to 5kc/s, falling by 6dB at 20c/s and by 9dB at 10kc/s.

(b) With equalization (driven from low-impedance source):

Level from 20c/s to 15kc/s falling by 3dB at 20kc/s.

Distortion Factor, measured at 1 000c/s:

Output (W)	10	20	30	40	50	60
Distortion (per cent)	0·5	0·7	0·85	1·0	1·3	1·5

Clipping starts at just over 60W and distortion rises very rapidly, reaching 10 per cent at 70W.

As previously stated, the amplifier output impedance is practically zero. The input impedance is 60kΩ and an input of 10mV at 1 000c/s is sufficient to give 60W output.

The distortion figures mentioned above were obtained with an *LCR* bridged-*T* circuit designed to reject the fundamental frequency of 1 000c/s. The residual signal was measured with a sensitive diode voltmeter of a type inherently prone to error when measuring complex waveforms. Accurate results call for the use of a meter which records true r.m.s. values.

Loudspeakers

Listening tests on f.m. broadcasts have been made using a loudspeaker combination consisting of a 15in low frequency unit, (Plessey, type CP73025/12/5), together with a single high-frequency unit, (G.E.C. Presence Unit, type BCS 1853). A conventional crossover divider unit was tried at first, but was abandoned in favour of a simpler arrangement described in a leaflet supplied with the G.E.C. speaker. Readers interested in high quality loudspeakers are referred to a paper[2] by D. E. L. Shorter in which the design of units for broadcast monitoring purposes is discussed. Some interesting measurements on loudspeakers are also described in the journal "Technique", issued by the Muirhead Company[3].

Conclusion

On live radio programmes the subjective quality of reproduction falls little short of that expected from a good valve amplifier. The maximum output power is of course grossly in excess of that required for normal listening, but it allows the amplifier to be run conservatively with a safe margin for heavy overloads.

Transient response is excellent due to the very low output impedance and although it is necessary to avoid the use of inductive loads there is otherwise no sign of instability in operation. The performance is marred by some residual hum and noise, due to the very high power gain of the amplifier, the transistor noise being enhanced by the high input and signal source impedances. A gain-reduction of about 12dB with a change of input impedance to around 1kΩ would probably improve the signal-to-noise ratio to something between 60 and 70dB.

REFERENCES

1. Van Abbe, H. H., Van Slagmaat, G. C. Non-Linear Distortion of Transistorised Amplifiers. *Electronic Applications 20*, 159 (Cleaver-Hume Press Ltd.).
2. Shorter, D. E. L. High Quality Monitoring Loudspeakers. *Proc. Instn. Elect. Engrs. 105B*, 607 (1958).
3. Cooke, R. E. Impedance and Phase Angle of Loudspeaker Loads. *Technique 13*, 2 (April 1959).

Twenty-Five Years of Television Broadcasting

The British Broadcasting Corporation has recently celebrated its first quarter of a century of television broadcasting, for it was on 2 November 1936 that a regular service was inaugurated.

This, then, is an opportune time to set forth a brief résumé of the early history of a development which has so profound an effect on the lives of people the world over.

Even twenty-five years ago television was no new concept. The expression was coined as long ago as 1900, and the ultimate roots go back at least as far as 1847, when Bakewell devised a system of transmitting still pictures over telegraph wires which incorporated the vital principle of scanning the subject piecemeal in a series of lines.

Attention was later turned to the problem of transmitting actual images and there were many experimenters in the field. A major development occurred in 1884, when Nipkow, a German engineer, patented an 'Electric Telescope' which embodied a spiral of holes in rotating disks at both the transmitting and receiving end, with the disks operating in synchronism to achieve a scanning process.

Nipkow's device did not work, but only because two key components were not then in existence—an efficient light-sensitive cell and the amplifying thermionic valve. In the years following, many proposals for a method of achieving television were put forward, but all failed for the same reasons.

A further advance came in 1907, when Rosing, a Russian professor, devised an apparatus which used mirror drum scanning at the transmitter and a cathode-ray tube (then in existence but in a very rudimentary state) for presentation of the received picture. This was followed in 1908 by a proposal by Campbell Swinton, one of the outstanding electrical engineers of his day, who outlined a scheme for scanning the image at the transmitter by a special type of cathode-ray tube, and presenting the picture on a c.r.t. at the receiver.

Campbell Swinton elaborated on his proposal in 1911, but never carried it beyond the theoretical stage; in fact he could not, because neither the special tube nor an efficient thermionic valve amplifier was available. Nevertheless, beyond dispute, Campbell Swinton's proposal embodied the basic principles of today's high definition television systems.

In the early 1920's interest in television was revived by a few workers, notably Baird in Britain and Jenkins in America. Baird experimented with Nipkow's apparatus of 1884 and by now having amplifiers at his disposal succeeded in transmitting shadows over a distance of a few feet in 1923. By 1926 he was able to give a demonstration of images transmitted with some degree of light and shade—very small, very low in definition and flickering, but undeniably pictures—the first in the world.

Baird, in a natural desire to recoup his Company's outlay, wished to put receivers (which he called 'Televisors') on the market, but to do this a public service had first to be established. Pressure was brought to bear on the BBC for the provision of this. Eventually, and rather reluctantly, two medium-wave transmitters (one for vision, one for sound) were put at Baird's disposal for a limited experimental service after normal programme hours. This began in 1930.

The BBC's reluctance was based on realism. Although the Baird 30-line, 12½-frame transmissions were exciting as a novelty, the entertainment value was negligible, the received images being tiny and almost completely lacking in detail. Furthermore, it was known at the time that big electronic organizations in this country and others elsewhere were actively interested in television, and that Campbell Swinton's ideas had been resurrected and showed promise.

Zworykin, of America, in his youth a pupil of Rosing's, had begun experiments on an all-electronic system in 1923, and if this came to fruition it would patently be much more acceptable than any mechanical scanning system could be. In 1929 Zworykin gave a public demonstration which proved this beyond doubt.

In Britain, Electric and Musical Industries Limited and the Marconi Company were both actively interested in television; furthermore, in the 1920's Marconi's had carried out intensive work on the development of a high-speed system of facsimile (still picture) transmission and in so doing had encountered and solved many of the problems inherent in the transmission of the high-definition television signals which were being visualized. When, in 1931, E.M.I. Ltd developed a 120-line mirror drum film scanner, the ultra-short wave transmitter necessary to radiate the signals was ordered from Marconi's. Thus began a close liaison between the two Companies' television development groups which intensified when in 1932 E.M.I.'s patented an electronic camera tube (the 'Emitron').

In 1934 a Committee under Lord Selsdon was set up by the British Government to look into the possibility of establishing a permanent television service. In the following January it made its report, which was to the effect that a high definition service should be established as soon as possible and that steps should be taken to find the most suitable system. In practice, this meant Baird versus Marconi-EMI.

In due course the rival Companies installed their vision equipment at Alexandra Palace, the chosen site of the London station. A common transmitter and a common aerial system, both manufactured by Marconi's, were used.

The Baird equipment employed 240-line scanning with 25 pictures per second, the scanning process being carried out by vastly improved Nipkow disks running at 6 000 rev/min in a vacuum.

The Marconi-EMI system operated on 405 lines with all-electronic interlaced scanning, using Emitron cameras as the picture source. Although the picture rate was nominally 25 per second, the interlacing provided an effective repetition rate of 50 per second, with a marked reduction in flicker.

On 2 November the station was formally opened, with Baird's and Marconi-EMI operating their equipments on alternate weeks.

On 5 February 1937 the Post Master General announced that henceforth only one system would handle the transmissions—the Marconi-EMI. Baird had paid the penalty for his adherence to mechanical scanning.

One of the most remarkable features of the chosen system has been its endurance for, with only very minor changes, the standards devised 25 years ago are the same as those at present used in this country, and it is perhaps ironic that while the name of John Logie Baird is familiar to all, the names of Schoenberg, Blumlein, Davis, Franklin and others who devised and pioneered the 405-line system are virtually unknown outside of engineering circles.

The facts upon which this résumé is based were provided by Marconi's Wireless Telegraph Co. Ltd to whom due acknowledgment is made.

Optimum Transistor Stabilization Networks

By J. D. Meindl* and O. Pitzalis*

A comprehensive design theory for transistor d.c. stabilization networks is described wherein the temperature sensitive device parameters, I_{CBO}, V_{BE} and h_{FE} are recognized. The effects of stabilization network resistor and power supply temperature variations are considered. Transistor parameter tolerances and resistor tolerances are also taken into account. The stabilization network is designed for minimum power dissipation.

(Voir page 831 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 838)

THIS article is concerned with the problem of optimizing the design of the d.c. stabilization network of a transistor circuit capable of performing as an audio, tuned or video amplifier, harmonic oscillator, modulator, mixer, detector, and the like. Previous stabilization analyses[1-4], which treat the temperature variation of I_{CBO} as the sole cause of instability, often result in suitable circuit designs for alloy junction germanium transistors, but this is

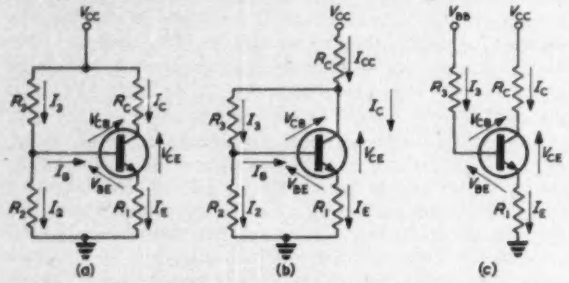


Fig. 1. Stabilization networks (a) and (b) single supply voltage (c) two supply voltages

ordinarily not true for silicon transistors, due to the sharply decreased magnitude of I_{CBO}. Analyses[5], which neglect the temperature dependence of the base-emitter diode conductance or the base-to-emitter voltage, V_{BE}, mask a major cause of instability in silicon transistor circuits. Those[6] which do not consider the temperature variation of h_{FE} are especially hampered for mesa transistors, whether germanium or silicon.

Other more complete analyses[7-8], with respect to consideration of the temperature dependent transistor parameters, I_{CBO}, V_{BE} and h_{FE}, do not discuss the effects of power dissipation, resistor temperature variation, transistor parameter tolerances and resistor tolerances on the design of a stabilization network. These latter factors are important in practical designs and must be recognized.

Design Theory

The primary goal of the design theory is to provide a firm basis for maintaining the d.c. operating point of a transistor within prescribed limits, over a finite temperature range, while dissipating a minimum amount of d.c. power in the circuit. The effects of predictable temperature variations in the stabilization network resistors and the supply voltages are considered. In addition, both active and passive component tolerances are investigated. The essence of the design procedure may be enumerated as follows:

(1) Anticipate the lower and upper operating temperatures, T_b and T_a respectively, of the circuit.

(2) Select the transistor operating point at T_b (i.e., the values of I_{Eb} and V_{CBb}) and T_a (i.e., the values of I_{Ea} and V_{CBa}). The operating points selected should reflect a reasonable amount of drift over the anticipated temperature range.

(3) (a) With the transistor at temperature T_b, measure I_{Bb} and V_{BEb} for the selected values of I_{Eb} and V_{CBb}.

(b) With the transistor at temperature T_a, measure I_{Ba} and V_{BEa} for the selected values of I_{Ea} and V_{CBa}.

(4) Write two sets of Kirchhoff equations for the circuit, one at T_a and one at T_b. This yields a set of four simultaneous equations containing the transistor currents and voltages and the stabilization network elements R_1, R_2, R_3, R_C and V_{CC} (see Fig. 1(a)).

(5) Since the transistor currents and voltages are known from (2) and (3), the set of equations may be solved in terms of these quantities and any one of the five stabilization network elements (e.g., R_1).

(6) Select a value for R_1 and compute the values of the remaining elements from the results of (5).

(7) Since the total power dissipation of the circuit is found to depend on the selected value of R_1, the power dissipation at the upper temperature P_a should be computed to permit the selection of R_1 for minimum power dissipation.

The first circuit configuration is shown in Fig. 1(a). The Kirchhoff voltage equations for the circuit are:

$$V_{CC} = I_C R_C + V_{CE} + I_E R_1 \quad \ldots\ldots\ldots (1)$$

$$V_{CC} = I_3 R_3 + I_2 R_2 \quad \ldots\ldots\ldots\ldots (2)$$

$$0 = V_{BE} + I_E R_1 - I_2 R_2 \quad \ldots\ldots\ldots (3)$$

$$V_{CE} = V_{CB} + V_{BE} \quad \ldots\ldots\ldots\ldots (4)$$

The Kirchhoff current equations are:

$$I_3 = I_2 + I_B \quad \ldots\ldots\ldots\ldots (5)$$

$$I_E = I_C + I_B \quad \ldots\ldots\ldots\ldots (6)$$

Substituting equation (5) into equation (2) and that result into equation (3) gives:

$$0 = V_{BE} + I_E R_1 - \frac{R_2}{R_2 + R_3}(V_{CC} - I_B R_3) \quad \ldots\ldots (7)$$

Writing equations (1) and (7) explicitly at the lower and upper temperature limits gives:

$$V_{CC} = I_{Cb} R_C + V_{CEb} + I_{Eb} R_1 \quad \ldots\ldots\ldots (8)$$

$$0 = V_{BEb} + I_{Eb} R_1 - \frac{R_2}{R_2 + R_3}(V_{CC} - I_{Bb} R_3)$$

at T_b, and

$$\gamma_V V_{CC} = \gamma_R I_{Ca} R_C + V_{CEa} + \gamma_R I_{Ea} R_1 \quad \ldots\ldots (9)$$

$$0 = V_{BEa} + \gamma_R I_{Ca} R_1 - \frac{R_2}{R_2 + R_3}(\gamma_V V_{CC} - \gamma_R I_{Ba} R_3)$$

* U.S. Army Signal Research and Development Laboratory, Fort Monmouth, New Jersey.

at T_a. The four equations (8) and (9) essentially contain nine unknowns, four describing the transistor's operating point at T_a and T_b and five pertaining to the resistor network and supply voltage. Specifying the required operating points gives I_{Eb}, V_{CBb}, I_{Ea} and V_{CBa}. Thus, one can immediately find I_{Bb}, V_{BEb}, I_{Ba} and V_{BEa} from measurement as previously described. The terminal equations of the transistor (4) and (6), may be used to calculate any remaining device voltage or current. This permits equations (8) and (9) to assume the most simple form which facilitates a solution. In these equations, the factors γ_R and γ_V are included to provide for temperature variations in the resistors and the supply voltage. The temperature factor γ_R may be defined as the ratio of the value of a resistor R at T_a to the value of R at T_b (i.e., $R(T_a)/R(T_b) = \gamma_R$) and similarly for γ_V. With the transistor currents and voltages determined, the five unknowns, R_1, R_2, R_3, R_C, and V_{CC}, remain in equations (8) and (9).

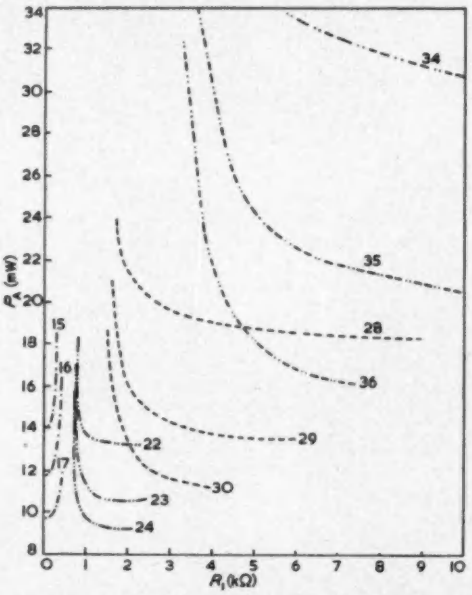


Fig. 2. Total circuit power dissipation at 100°C (P_a) versus external emitter resistance (R_1) at various stabilities (see Table 1)

From this point, a convenient approach is to solve the system of equations (8) and (9), in terms of R_1. Thus,

$$V_{CC} = \frac{\gamma_R C_1 R_1 + b_1}{\mp a_2}$$

$$R_2 = \frac{(\gamma_R C_1 R_1 + b_1)(a_1 R_1 + d_1)}{-a_1(\gamma_R C_1 R_1 + b_1) + a_2(b_1 + b_2)} \quad \ldots\ldots (10)$$

$$R_3 = \frac{(\gamma_R C_1 R_1 + b_1)(a_1 R_1 + d_1)}{a_2(\gamma_R C_1 R_1 + b_1) - a_2(b_1 + b_2)}$$

$$R_C = \frac{(a_1 R_1 + d_1) + d_2}{-a_2}$$

where a_1, a_2, and so forth are constants for a given stability specified in the Appendix. In order that all circuit parameters given by equation (10) be positive quantities, R_1 must lie within a prescribed range for each stability under consideration. It is not feasible to solve, as an inequality, each of these equations, since in general the signs of the constants a_1, a_2, and so forth are unknown, and thus the sense of an inequality would be in doubt. A practical procedure is to solve set (10) for the values of R_1 at all poles and zeroes of the four equations. The results of this are shown below.

$$R_1 = \frac{-b_1}{\gamma_R C_1}$$

$$R_1 = \frac{-d_1}{a_1}$$

$$R_1 = \frac{(a_2/a_1)(b_1 + b_2) - b_1}{\gamma_R C_1} \quad \ldots\ldots (11)$$

$$R_1 = \frac{b_2}{\gamma_R C_1}$$

$$R_1 = \frac{d_1 + d_2}{-a_1}$$

The pole and zero values of R_1, given by equations (11), may be plotted on a horizontal scale. Discounting all negative values, the allowable range for R_1 for any stability may be determined by calculating a test set of parameters from (10) for a value of R_1 between successive poles or zeroes and between the origin and the first positive pole or zero.

For each stability, various values of R_1 within the allowable range may be chosen and the circuit designs completed via equations (10). In selecting a particular design, a.c. performance features must be considered. However, a purely d.c. performance feature of prime importance is the d.c. power drain or power dissipation of the circuit. The dissipation at the upper temperature limit is of most concern. From Fig. 1

$$P_a = \gamma_V V_{CC}(I_{Ea} + I_{Ba}) \quad \ldots\ldots (12)$$

which may be rewritten as

$$P = (\gamma_V/\gamma_R)\ V_{CC}\left[\frac{\gamma_R I_{Ca} R_2 + \gamma_R I_{Ba} R_2 + \gamma_V V_{CC}}{R_2 + R_3}\right] \ldots (13)$$

Manufacturing tolerances in the transistor parameters may be represented as additional spread in I_B and V_{BE} which must be stabilized. Thus, instead of substituting the exact measured values of I_{Bb}, V_{BEb}, I_{Ba} and V_{BEa} in equations (10) the values for these quantities should reflect a reasonable manufacturing tolerance. For example, if measurements show I_{Bb} increases as temperature decreases for fixed I_E and V_{CB}, then the largest I_{Bb} for the lot of transistors to be stabilized should be used in equations (10); if I_{Ba} decreases as temperature increases for fixed I_E and V_{CB}, then the smallest I_{Ba} for a lot of transistors should be used in equations (10). Although it is expected that no single transistor in a lot will run the full range between the design limits of I_B and V_{BE}, it is certain that all transistors in the lot will fall somewhere within the limits.

Manufacturing tolerance, ageing changes, and other deleterious factors constitute collectively the tolerance on the resistors in the stabilization network. From inspection of the external circuit equations and the circuit itself, the combinations of resistor and voltage supply tolerances that result in the maximum positive or negative operating point deviations, $\pm\delta I_E$ and $\pm\delta V_{CB}$, may be found[9]. For example, the worst conditions for maximum positive shift in emitter current, δI_E, occur when the following tolerances prevail for the circuit: $+\delta V_{CC}$, $-\delta R_1$, $+\delta R_2$, $-\delta R_3$ and $-\delta R_C$. From equations (8) and (9) one may write

$$I_{Eb} = \frac{\dfrac{R_2}{R_2 + R_3} V_{CC} - V_{BEb} - \dfrac{R_2 R_3}{R_2 + R_3} I_{Bb}}{R_1} \quad \ldots (14)$$

$$V_{CBb} = V_{CC} - V_{BEb} - I_{Eb}(R_1 + R_C)$$

and

$$I_{Ba} = \frac{\gamma_V \frac{R_2}{R_2 + R_3} V_{CC} - V_{BEa} - \gamma_R \frac{R_2 R_3}{R_2 + R_3} I_{Ba}}{\gamma_R R_1}$$

$$V_{CEa} = \gamma_V V_{CC} - V_{BEa} - \gamma_R I_{Ba}(R_1 + R_C) + \gamma_R I_{Ba} R_C. \quad \ldots\ldots\ldots (15)$$

Having first calculated the circuit design, assuming no tolerance in the resistors and supply voltage, equations (14) and (15) may be used to calculate the new limits of the operating point for any chosen set of tolerances for the circuit. For the first iteration, the I_B and V_{BE} values can be assumed as those existing for exact resistance values. Subsequent iterations may employ I_B and V_{BE} values corresponding to the latest operating points calculated from equations (14) and (15). In this way, a quantitative measure of the effect of resistor and supply voltage tolerance on circuit stability may be determined.

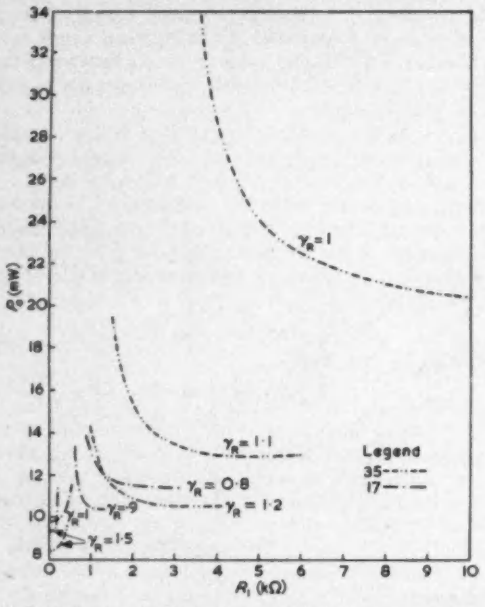


Fig. 3. Total circuit power dissipation at 100°C (P_a) versus external emitter resistance (R_1) at two typical stabilities (No. 17 and No. 35) and various resistor network temperature factors (γ_R)

Frequently the value of V_{CC} computed from equations (10) may be inconvenient to obtain exactly (e.g., 13·02V). In such cases, one may choose the nearest convenient value of V_{CC} (e.g., 12·00V) and solve the first equation of (10) for the corresponding

$$R_1 = \frac{a_2 V_{CC} + b_1}{-\gamma_R C_1} \quad \ldots\ldots\ldots (16)$$

Using equations (10), the design continues as prescribed, provided the value of R_1 given by equation (16) falls within an allowable range as set by equations (11).

Compared with previous treatments of the transistor d.c. stabilization problem[1-8], the present effort is poorly suited for analysis but very well suited to design. Especially, when all three temperature sensitive parameters (i.e., I_{CBo}, and V_{BE} and h_{FE}) are considered, the present design procedure is relatively straightforward and leads to circuits whose calculated and measured performance are in outstanding agreement. By directly employing values of I_B and V_{BE} measured at the limiting temperature and d.c. operating points of the transistor, in a simple manner the design effectively utilizes an exact description of the transistor characteristics and their temperature variation. Thus, no unnecessary power is dissipated in the stabilization network to swamp out any neglected temperature dependence in the transistor parameters. In addition, there is no loss of accuracy in the present procedure for large changes in transistor parameters. However, added caution must be taken if a parameter does not vary monotonically with temperature. In such cases, stable designs may be assured by employing in the computations the largest and smallest values of a parameter even though they may not occur at limiting temperatures. Temperature variations in the stabilization network resistors and supply voltage are accounted for via the γ_R and γ_V factors. This approach does not imply the exact functional nature of the resistor temperature dependence. Finally, using for example, equations (10), (11), and (13), the computational labour involved in designing a circuit is surprisingly small, especially after one acquires a feel for the process.

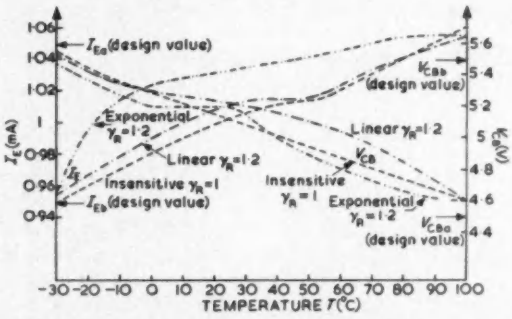


Fig. 4. Measured variation of emitter current (I_E) versus temperature (T) for a temperature insensitive resistor network ($\gamma_R = 1{\cdot}0$) and linear and exponential resistor temperature dependencies ($\gamma_R = 1{\cdot}2$)

The analysis of circuits (b) and (c) of Fig. 1 follows the pattern previously described for circuit (a) rather closely.

Experimental Results

The results of applying the design theory derived in the preceding section are now presented. The various facets of the stabilization problem are treated in the same sequence in which they were previously discussed. Table 1 shows the standard set of 36 stabilities for which stabilization network designs are computed. Stability number 17, for example, permits I_E and V_{CE} to vary from 0·7mA to 1·3mA and 5·5V to 4·5V, respectively. Stability number 36 represents the tightest case. Hereafter, all stabilities are referred to by an identification number as designated in this Table.

For a typical npn silicon alloy diffused transistor in circuit (a), Fig. 2 shows the total circuit power dissipation at 100°C versus R_1 for various stabilities. The resistors and voltage supply are assumed temperature insensitive. It is most interesting to note that especially for tight current and voltage stabilities (e.g., cases 30, 35, and 36) P_a is a rapidly varying function of R_1. The curve for stability number 36 indicates that P_a essentially doubles from 16mW as R_1 is reduced from 7kΩ to 3·2kΩ. For each stability, the values of R_1 for which P_a was computed extend from 105 per cent of the lower limiting

TABLE 1

D.C. Stability Index

STABILITY* IDENTIFICATION NUMBER	I_{Eb}(mA)	I_{Ea}(mA)	V_{CBb}(V)	V_{CBa}(V)	ΔI_E(mA)	ΔV_{CB}(V)
1	0·30	2·0	8·00	3·00	1·7	5·0
2			7·00	3·00		4·0
3			6·50	3·50		3·0
4			6·00	4·00		2·0
5			5·50	4·50		1·0
6			5·25	4·75		0·5
7	0·60	1·40	8·00	3·00	0·8	5·0
8			7·00	3·00		4·0
9			6·50	3·50		3·0
10			6·00	4·00		2·0
11			5·50	4·50		1·0
12			5·25	4·75		0·5
13	0·70	1·30	8·00	3·00	0·6	5·0
14			7·00	3·00		4·0
15			6·50	3·50		3·0
16			6·00	4·00		2·0
17			5·50	4·50		1·0
18			5·25	4·75		0·5
19	0·80	1·20	8·00	3·00	0·4	5·0
20			7·00	3·00		4·0
21			6·50	3·50		3·0
22			6·00	4·00		2·0
23			5·50	4·50		1·0
24			5·25	4·75		0·5
25	0·90	1·10	8·00	3·00	0·2	5·0
26			7·00	3·00		4·0
27			6·50	3·50		3·0
28			6·00	4·00		2·0
29			5·50	4·50		1·0
30			5·25	4·75		0·5
31	0·95	1·05	8·00	3·00	0·1	5·0
32			7·00	3·00		4·0
33			6·50	3·50		3·0
34			6·00	4·00		2·0
35			5·50	4·50		1·0
36			5·25	4·75		0·5

* *Note that the stability identification number is merely an identifying symbol and does not in itself indicate the degree of stability of a circuit.*

value to 95 per cent of the upper limiting value. The left portion of Fig. 2 indicates P_a is a minimum for a particular current stability. Tight current stabilities require relatively greater power dissipation to maintain small operating point drifts, while loose current stabilities require relatively greater power in order to force the transistor to drift through an over-extended range. Although power dissipation decreases monotonically with tighter voltage stability, a lower limit on ΔV_{CB} is imposed by the minimum required resistance R_C. Curves analogous to those of Fig. 2 reveal that power dissipation for a given stability is essentially equal for circuits (a) and (b). Dissipations of the order of 20 to 30 per cent lower are possible with circuit (c) where the P_a versus R_1 curves are linear.

Typical examples of the effect of a temperature dependent stabilization network are shown in Fig. 3. The results are most surprising as the curves for stabilities 17 and 35 indicate. For a tight stability, such as number 35, the minimum power dissipation required for temperature invariant resistors is approximately 21mW. For a positive temperature coefficient stabilization network with the temperature factor $\gamma_R = 1{\cdot}2$, the minimum required power is reduced to less than 11mW. The reduction in dissipation is far more favourable for the case where $\gamma_R = 1{\cdot}2$ if intermediate values of P_a are compared; for $R_1 = 3{\cdot}5k\Omega$ $P_a = 34mW$ with $\gamma_R = 1{\cdot}0$ is reduced to $P_a = 10{\cdot}5mW$ with $\gamma_R = 1{\cdot}2$. Stability number 35 cannot be realized with a temperature factor $\gamma_R = 0{\cdot}9$. It is evident that intermediate current stabilities such as 17 are affected comparatively little by either positive or negative temperature variation in the resistors if it remains moderate. For the tight stabilities which are necessary to combat transistor and resistor tolerances, computations of the type indicated in Fig. 3 show that resistor networks with temperature factors less than unity ($\gamma_R < 1$) or negative temperature coefficients are undesirable because of the excessive power dissipation required for stable operation. On the other hand, temperature factors larger than unity markedly reduce the power dissipation required for a given stability.

Another technique which may be used to advantage in stabilizing an operating point is a supply voltage with a negative temperature coefficient. A temperature factor less than unity (i.e., $\gamma_V < 1$) can easily provide 3 to 1 reductions in circuit power dissipation. If $\gamma_V > 1$, the power requirement rises extremely rapidly for tight current stabilities while more loose stabilities are less affected.

Fig. 4 shows typical measured curves of operating point versus temperature for several circuit designs. The measured performance is in close agreement with the design goals, which indicates the accuracy which is possible

using the present design theory. Operating point drift is shown for linearly and exponentially temperature dependent stabilization networks as well as for the temperature insensitive case. These curves illustrate the utility of the design theory.

In the present design procedure, transistor tolerance is

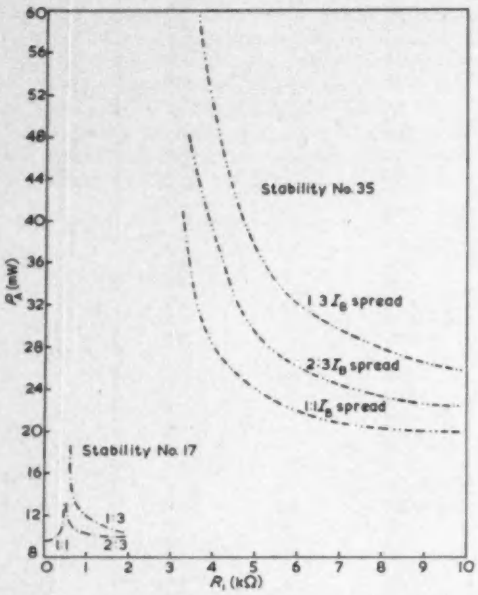


Fig. 5. Total circuit power dissipation at 100°C (P_a) versus external emitter resistance (R_1) at two typical stabilities (No. 17 and No. 35) and various transistor base current manufacturing tolerances (I_B spreads)

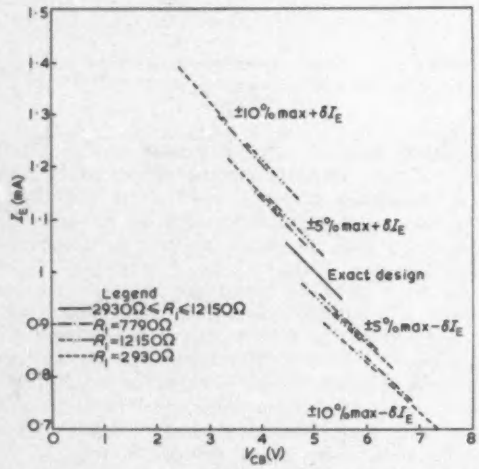


Fig. 6. Range of operating point variation (i.e., of I_E and V_{CB}) for exact resistor values and the two worst sets of resistor values (with respect to deviations in emitter current, ± $^{\delta}I_E$) for ± 5 per cent and ± 10 per cent tolerance

reflected principally in the values of I_{Bb} and I_{Ba} used in the calculations. Primarily, the differences in current gain in a group of silicon transistors are reflected in the I_B tolerance. The relatively small tolerance expected for V_{BE} may be treated in the same fashion as the I_B tolerance. Specifically, for a group of transistors to be stabilized, the largest expected value of $I_{Ba}I_{Bb}$ for the group and the smallest expected value for the group are used in the stabilization network calculations; the largest V_{BEb} and the smallest V_{BEa} should be used. Although this scheme of accounting for tolerances is not infallible theoretically, it can be correctly argued that it yields more stable circuits than a design based on nominal I_B and V_{BE} values. On the basis of experimental evidence, it appears to be very adequate.

An additional factor in its favour is the negligible additional effort required to account for transistor tolerances.

The cost of stabilizing against transistor manufacturing tolerances is indicated by the typical curves of Fig. 5. It is particularly for the most stable circuits (e.g., case 35) that the effect of including tolerances is most noticeable. However, even in such cases, relatively modest increases in power dissipation are the chief penalty to be paid for stabilizing against transistor tolerances. It is interesting to observe that Fig. 5 shows P_a varies more rapidly with R_1 for larger I_B spreads. (For a '1:2 I_B spread' I_{Bb} is multiplied by 4/3 and I_{Ba} by 2/3 giving a 2/3:4/3 or 1:2 spread.)

For a typical case, stability number 35, Fig. 6 graphically illustrates the range of operating point drift for both ± 5 and ± 10 per cent resistor tolerances at three values of R_1. The shift of the entire operating range for a given tolerance is shown. Fig. 6 indicates that operating point deviation due to resistor tolerance must be offset by originally designing for tighter stabilities which in turn require increased power dissipation.

Conclusions

In this article, the results indicate that for a transistor d.c. stabilization network a careful choice of both the operating point stability and the external emitter resistor (R_1) can significantly reduce power dissipation. The design procedure yields circuits whose predicted and measured performance are in close harmony.

Appendix

The equations of frequently used constants are listed below.

$$
\begin{aligned}
a_1 &= \gamma_E I_{Ea} - \gamma_V I_{Eb} \\
a_2 &= \gamma_E I_{Ca} - \gamma_V I_{Cb} \\
a_3 &= \gamma_E I_{Ba} - \gamma_V I_{Bb} \\
b_1 &= V_{CEa} I_{Cb} - \gamma_R V_{CEb} I_{Ca} \\
b_2 &= V_{BEa} I_{Bb} - \gamma_E V_{BEb} I_{Ba} \\
b_3 &= V_{CBa} I_{Eb} - \gamma_E V_{CBb} I_{Ea} \\
b_4 &= V_{CBa} I_{Bb} - \gamma_E V_{CBb} I_{Ba} \\
c_1 &= I_{Ea} I_{Cb} - I_{Eb} I_{Ca} \\
d_1 &= V_{BEa} - \gamma_V V_{BEb} \\
d_2 &= V_{CBa} - \gamma_V V_{CBb} \\
e_1 &= V_{CBa} V_{BEb} - V_{CBb} V_{BEa}.
\end{aligned}
\qquad \ldots\ldots\ldots (17)
$$

References

1. Shea, R. F. Transistor Operation: Stabilisation of Operating Points. *Proc. Inst. Radio Engrs. 40*, 1435 (1952).
2. Shea, R. F., *et al.* Principles of Transistor Circuits. (Wiley, New York, 1953).
3. Shea, R. F. Transistor Circuits Engineering. (Wiley, New York, 1957).
4. Ghandhi, S. K. Analysis and Design of Transistor Bias Networks. *Proc. Nat. Electronics Conf. 12*, 491 (1956).
5. Lo, A. W., *et al.* Transistor Electronics. (Prenctice Hall, N.J. 1955).
6. Lin, H. C., Barco, A. A. Temeperature Effects in Circuits Using Junction Transistors. Transistors Vol. I p. 369 (RCA Laboratories, N.J. 1956).
7. Vallese, L. M. Temperature Stabilization of Transistor Amplifiers. *Commun. and Electronics.* No. 26, 379 (Sept. 1956).
8. Schartz, S. Selected Semiconductor Circuits Handbook (Wiley, New York, 1960).
9. Meindl, J. D., Pitzalis, O. Optimum Stabilization Networks for Functional Electronic Blocks. *Proc. Nat. Electronics Conf.* (Oct. 1960).

A SIMPLE PHASE DETECTOR

By G. S. P. Scantlebury*

This article describes a form of phase-sensitive detector where the reference signal and the variable signal have a common terminal, which can be earthed. The number of components required are very few, and no special centre-tapped transformers are required. Designed originally to detect the output from an a.c. bridge, it was found to have other valuable properties. Some of these are discussed in the article and a full analysis of the general case is given in the Appendix

(Voir page 831 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 838)

THERE are many occasions in which some form of a.c. bridge is used in a feedback circuit or servo-loop and where a d.c. potential is obtained by rectifying the a.c. output from the bridge. The direction of d.c. potential-change reverses as the point of balance is crossed, which will lead to positive feedback, unless a phase detector is used. This will give a d.c. change continuous in sense as the point of balance is crossed, with possibly zero potential at balance, although a fixed d.c. potential may be added to all output levels to act as bias to the next stage which is operated by the bridge output. Such phase detectors have also been called phase sensitive detectors or synchronous rectifiers.

Most phase detectors in the past have required isolating transformers, some of whose windings may be floating relative to earth. This may be an embarrassment and even required special shielding from pick-up, as well as giving unwanted capacitance effects.

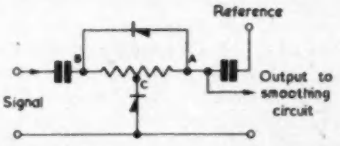


Fig. 1. The phase detector in its simplest form

The phase detector described here[1] uses very few components, and has the advantage that both the reference signal and the bridge output can have a common earth return. Either or both signals can therefore be a.c. coupled from a preceding valve or valves in the simplest way.

Fig. 1 shows the phase detector in its simplest form. The output is taken from the reference end, and, after smoothing to remove the a.c. component, gives a d.c. which is zero at zero signal input, and either positive or negative to earth depending on whether the signal is in phase or in anti-phase with the reference signal of the same frequency. Fig. 2 shows the d.c. potential output as the a.c. signal amplitude is varied. Should the signal reach a higher amplitude than the amplitude of the reference signal, then the output will ideally have a value equal to the maximum value of the reference sine wave, but below this level, the output will be equal to the maximum value of the signal sine wave.

Fig. 3(a) shows the waveforms and relative potentials at the three reference points. (a) is the reference waveform, (b) is the signal waveform, and (c) is the mean of these, found at the centre tap between the reference points. The top diode D_1 conducts to prevent point A becoming positive to B, redistributing the charges in the capacitors. The bottom diode D_2 conducts to prevent the average signal falling below earth potential. The two instants are indicated by D_1 and D_2 on the waveforms. The mean potential at A is here positive to earth. If both diodes are reversed the figure requires an inversion of signs only, and the output from A is then negative for the amplitudes shown. Fig. 3(b) shows the levels when the signal B is zero. The average

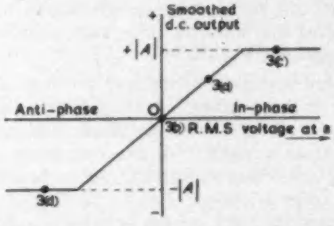


Fig. 2. D.C. output against a.c. input

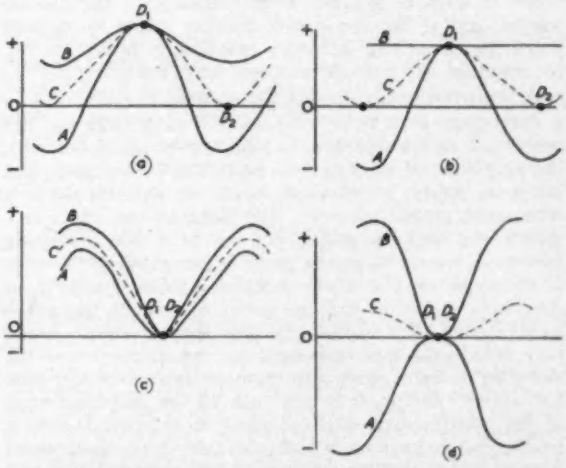


Fig. 3. (a) Waveforms for signal in phase with greater reference amplitude
(b) Waveforms for zero signal
(c) Waveforms for signal in phase with lesser reference amplitude
(d) Waveforms for signal anti-phase to lesser reference

signal at C is clearly half the value of the reference signal at A, and this brings the mean level of A to earth potential. Fig. 3(c) shows the levels when the signal at B is of greater amplitude than the reference signal at A. The two diodes now conduct at the same instant, and for all such larger signals the negative peak of A is held at earth potential so that the d.c. output, i.e. the mean potential at A, has a fixed value equal to the maximum value of the reference signal, as is shown in Fig. 2. All these figures refer to an in-phase signal. Fig. 3(d) shows an anti-phase signal at B, but where the signal B is again greater than the reference signal. The mean signal C is at its most negative at the moment the reference signal is at its positive peak, and will be so for

* *E.M.I. Electronics Ltd.*

all the larger signals at B. The mean potential of A, the output, remains at a negative value equal to the amplitude of the reference sine wave. The general case of an anti-phase signal is of similar type, but the average signal C will have its negative peak in phase with the reference as B is reduced and thus the mean level of the reference signal will be less negative. These examples explain the operation behind the results shown in Fig. 2.

A full analysis of this circuit for cases where there is a general phase difference between the signal and the reference is given in the Appendix; and from this certain other useful properties emerge.

In cases where $A \geqslant B > 0$, the output will be zero whenever the phase between the signal and the reference is exactly $\pi/2$ or $3\pi/2$. This, then, is a useful detector of quadrature between two unequal signals of the same sinusoidal frequency. Furthermore, the output, either side of zero, being of opposite sign and continuously variable through zero, can be made a control signal to return the phase to $\pi/2$, if the phase is made dependent on a voltage level (see Appendix Fig. 7).

The detector so far discussed had a centre-tapped resistance to derive the average signal, but other fixed tapping points can be used for the bottom diode. The range of useful positions is from a point $\frac{1}{4}$ of the way from A towards B right up to point B (see Appendix). In particular, if the tap is taken $\frac{1}{3}^{rd}$ from A, then if A = B, the output will be zero when the phase lag of B on the reference is 120° or 240°. Thus, two such detectors each supplying centre-zero meters can be made to indicate the angles of error relative to one phase of each of the two other phases of a three-phase supply, and if the two phases can be varied by control potentials, these two detectors can supply those controls, to maintain the true three-phase relationship.

In a particular application for locating shorted turns in a flat-wound strip electromagnet coil, a variable tap has been used. In the vicinity of a high resistance shorted turn, the amplitude of the magnetic field does vary slightly, but not so noticeably as its phase, which can pinpoint the turn with much greater accuracy. The phase of the signal in a search coil pick-up probe, relative to a 50c/s exciting current is measured, as the probe is presented to the edge of the windings. The reference signal is taken directly from the 50c/s supply to the coil under test, while the probe signal is amplified to equality with the test signal. These two signals are now presented to the detector and the slider (c) of the tapping potentiometer is adjusted for zero d.c. output. The phase is now read off the calibrated scale of the potentiometer and corrected in accordance with a coarse switch position which can add 2π in four equal steps of $\pi/2$ so that the reading is in the most sensitive part of the calibration. An amplifier with large delayed a.g.c. can keep the signal level nearly constant as the probe is moved radially across the windings of the magnet coil under test, and the phase indicator can be held at zero easily, during the traverse, by adjusting the potentiometer. As a shorted turn is approached it becomes more difficult to keep pace. From here on a record of radial position of the probe and of phase is kept until the short has been passed over, when the rest of the run may not require recording. An examination of the radius/phase plot is then used to locate the shorted turn.

There are numerous applications where this phase detector circuit requiring only unbalanced inputs will have advantage over existing types, such as a.f.c. circuits, f.m. demodulators using a high-Q circuit to generate phase modulation from the frequency modulated signal, d.c. servos operated from a.c. synchro circuits, etc.

Acknowledgments

Acknowledgments are due to the Directors of E.M.I. Electronics Ltd. for permission to publish this article.

Appendix

Let the potential relative to earth at A and B be written $M + A\sin\theta$ and $m + B\sin(\theta - \phi)$ respectively, where ϕ is the angle by which the signal lags the reference. Then the potential at C will be the average of these two signals, namely:

$$\tfrac{1}{2}[(M + m) + 2C\sin(\theta - \alpha)]$$

where $\alpha = \tan^{-1}\dfrac{B\sin\phi}{A + B\cos\phi}$

and $2C = [A^2 + B^2 + 2AB\cos\phi]^{\frac{1}{2}}$

Let the angular time at which the top diode conducts be written θ_1, and this is the moment when all three signals are at the same potential, and have the same slope, as shown in Fig. 4.

The slope S will be:

$$A\cos\theta_1 = B\cos(\theta_1 - \phi) = C\cos(\theta_1 - \alpha)$$

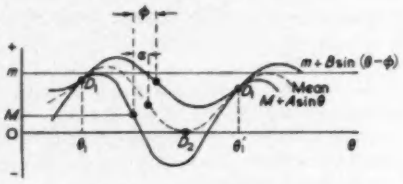


Fig. 4. Waveforms for the general case

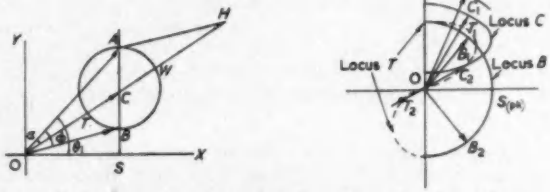


Fig. 5. (left) Vector representation of Fig. 4 shown at angular time θ_1
Fig. 6 (right) Loci of vectors as relative phase of the signal varies

from which:

$$\theta_1 = \tan^{-1}\frac{A - B\cos\theta}{B\sin\theta}$$

Now the bottom diode conducts when the potential of the mean signal at C is zero, and when:

$$\sin(\theta - \alpha) = (-1)$$
$$\therefore\ \tfrac{1}{2}[(M + m) + 2C(-1)] = 0$$
$$\therefore\ (M + m) = 2C$$

Substituting this result into the expression for the average signal gives:

$$C[1 + \sin(\theta - \alpha)]$$

Since all three waveforms have the same potential at θ_1:

$$M + A\sin\theta_1 = C[1 + \sin(\theta_1 - \alpha)]$$

from which the value of M can be calculated in terms of A, B and ϕ given above. This is the output from the bridge.

Fig. 5 embodies these calculations in vector form in which OA is shown in the position θ_1 at which the top diode conducts, with OB lagging by a fixed angle ϕ. The mean vector OC lags OA by the angle α. OH is the sum of vectors OA and OB and is of length $2 \times OC$. Since OS

has the value $OA\cos\theta_1$ and $OB\cos(\theta_1 - \phi)$ and $OC\cos(\theta_1 - \alpha)$, then $|OS|$ is equal to the slope of all three waveforms at the moment the top diode conducts. This means that as θ increases from OX, the three vectors maintaining a fixed angular relationship to each other, then

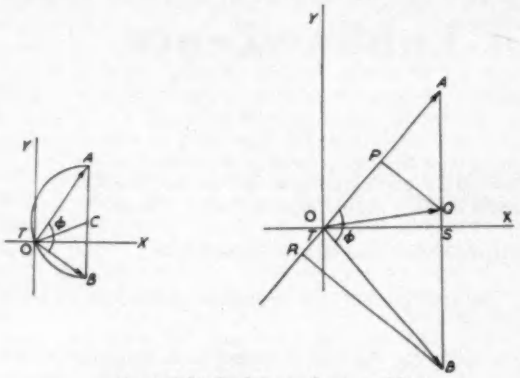


Fig. 7 (left) Special case for $\phi = 90°$
Fig. 8. (right) Vectors for the case where the resistance is not centre-tapped

when θ has the special value θ_1 the line ACB becomes normal to the OX axis, with intercept at S as shown.

The length $|AC| = |AS| - |CS| = A\sin\theta_1 - C\sin(\theta_1 - \alpha)$. Now, $M = C[1 + \sin(\theta_1 - \alpha)] - A\sin\theta_1$, and from the last result $M = |OC| - |AC|$ and this is shown in Fig. 5 by the length $|OT|$. It can be shown that $m = |OW|$, since $OT + OW = OH = 2C$.

Fig. 6 shows how the vectors can vary for a fixed ratio $1 > B/A > 0$ and with $\theta = \theta_1$ as the phase-angle ϕ varies from 0 to π. One position along the locus of A is shown, and it can be seen there are two possible values for each of the other quantities. The locus of A has only the segment shown, and in its extreme position gives the maximum value to OS, when $|OS| = |OB|$. The output of the detector is the distance from the relevant point on the locus of T to the origin, and the fact that this locus passes through the origin, and terminates at the value of B on the YOY' axis presents special cases.

Fig. 7 shows the special case of T at the origin, when $\phi = \pi/2$ and $A > B > 0$. AB is the diameter of a semicircle, centre at C, and passing through the origin. The output of the detector is zero. The use of this has been discussed in the text.

The special case where T lies on the Y-axis is discussed in the text in connexion with bridge applications.

For this case $|OT| = |OB|$ and has the positive sign for $\phi = 0$ and the negative sign for $\phi = \pi$.

Fig. 8 shows the two vectors $|OA| = |OB|$, which brings the mean signal in line with the X-axis so that $|OC| = |OS|$. OA is bisected normally at P by a line cutting AB in Q. This point Q is equidistant from A and the origin. BR is drawn normal to OA. Now the line AB represents the locus of all vectors representing the potentials of all points along the resistance between A and B in Fig. 1, and, for the particular phase angle ϕ of Fig. 8, the vector OQ represents the sine wave at a point along this resistance having the ratio AQ/AB from A. If the bottom diode is tapped at this point, and since $|AQ| = |QT|$ the output of the detector will be zero. With the tap at Q as defined, this condition is satisfied only for the value of ϕ shown, but, for each value of ϕ from $\pi/3$ to π, a position can be found for the tap to bring the output to zero.

Now:

$$AQ/AB = AP/AR$$

where $|AP| = A/2$ and $|AR| = [A - B\cos\phi]$

and $A = B$ for this case.

$$\therefore\ AQ/AB = \frac{1}{2[1 - \cos\phi]}$$

(In the previous case $A \neq B$, $\phi = \pi/2$ so that $|AR|$ was independent of B).

For the special case discussed in the text where $\phi = 120°$, $\cos\phi = -\frac{1}{2}$ and $AQ/AB = \frac{1}{3}$.

The smallest value usable is when $\phi = 60°$, which makes $AQ = AB$ and the tap is at B in Fig. 1, and the largest value is when $\phi = 180°$ and $AQ/AB = \frac{1}{4}$.

REFERENCE

1. Prov. British Pat. Appln. 2532/60.

Automatic Data Acquisition for Transistor Life Testing

The Electronics Division of Microcell Limited, a subsidiary of BTR Industries Limited, has installed automatic data acquisition equipment in the new semiconductor plant of Texas Instruments Ltd. This equipment was specially designed by Microcell to record the results of parameter measurements made on 2 000 transistors which are on extended life test.

Although completely automatic scanning of the 2 000 devices on test is desirable, the cost of such an installation could not be economically justified, and a reasonable compromise between completely automatic and completely manual operation had to be reached. The final arrangement involves manual selection of the device to be tested, with parameter circuit configuration, measurement and recording being automatic.

The input leads for the 400 devices in each oven are terminated in 40 separate modules which are housed in a double bay distribution rack; thus a total of five double bay distribution racks are required for the 2 000 transistors. Each module carries on the front panel a multi-way socket and an 11 way switch which enables the devices to be selected 10 at a time. An operator inserts a special plug with pistol grip into the multi-way socket and selects the device required on the rotary switch, which only releases the selected device from dissipation. The multi-way plug has a flying lead which connects the device to the automatic measuring equipment, and the plug also incorporates interlock wiring, monitor lamp and trigger switch to start the automatic testing equipment.

When the plug is inserted and the first device has been selected, the monitor lamp on the pistol grip will light—provided the data handling equipment is in its start condition; operation of the trigger switch will then start the automatic testing sequence. The parameter data of each device is recorded on a punched card and also in tabulated form on a typewriter. A separate punched card is used for each device and it is necessary to record other identifying information on each card with the data; this consists of the date, time and device number. The date is derived from a date switch, the time from a digital clock and the device number from a discrete coding system within the distribution racks. This block of information is punched out on the card (by an IBM punch) and typed in tabulated form (by an Addo-x printing tabulator) before any measurements are made.

On completion of this part of the record, the device is connected into the first of its parameter test configurations and a digital voltmeter is connected to the required test point. A delay of 100msec is introduced for the device to settle into its new circuit and the digital voltmeter is given a 'digitize' pulse. When the digital voltmeter has completed its conversion, the digital measurement is read out into the card punch and the tabulator. During the period of time that the punch and typewriter are recording the information, the device is returned to full dissipation conditions. The transistor is then connected into the next test configuration, where it is allowed the same settling time, the digital voltmeter takes the next reading and its data is read out to the IBM punch and the Addo-x tabulator. This process is repeated until all the required parameters have been recorded, after which the card punch ejects the card, and the tabulator makes a carriage return and line shift.

The Measurement of Luminescence

By G. P. Burn*

This article describes how a very faint luminescence can be measured by counting the output pulses from a photomultiplier. The complete equipment consists of the photomultiplier and power supplies and a pre-amplifier, the output of which is fed to a standard pulse height discriminator and scaler.

(Voir page 831 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 838)

A PHOTOMULTIPLIER consists of a photo-sensitive surface together with an electron multiplier in the same envelope. The photo-sensitive surface emits electrons when light falls upon it. The quantum efficiency of this process is not very high, often as many as 100 quanta being necessary before 1 electron is emitted. Each emitted electron passes into the multiplier and gathers up a large number of secondary electrons. The time spread of these electrons is about 10nsec: that is to say they form an exceedingly short pulse.

A Mazda 27M1 is a 9-stage photomultiplier with a nominal gain of 10^6 at 100V per stage. Each stage multiplies 4 or 5 times. Although the average multiplication is 10^6, the actual multiplication of each individual photo-electron will be between the limits of 4^9 (262 000) and 5^9 (1 950 000).

The output pulses may be observed with the circuit of Fig. 1. The anode of the photomultiplier is connected to earth by the resistor R, and the capacitor C represents the stray capacitance. On the oscilloscope (Cossor Model 1035) the negative-going pulses have a range of amplitudes from about 2 to 12mV. This range is independent of the value of R, but inversely proportional to the value of C. Evidently the magnitude of the pulses is governed by the relationship:

$$Q = CV \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

whence $C = 1{\cdot}59 \times 10^{-19} \times 1{\cdot}95 \times 10^6 / 12 \times 10^{-3}$ Farad

$= 26$pF

which is a reasonable value for the stray capacitance.

Dark Current

A photomultiplier, in common with other light sensitive devices, passes a certain amount of current even when no light is falling upon it. This current is called the dark current. The luminescence to be measured (see below) is a very weak illumination and may be zero, so it is necessary to determine the dark current with precision.

The dark current of a 27M1 is about $10^{-4}\mu$A. This current can be measured directly by a very sensitive galvanometer, but such an instrument is expensive. It is simpler to take advantage of the fact that the output is in the form of pulses, and to count them.

The dark current of $10^{-4}\mu$A can be converted into pulses per second given the size of the average pulse (10^6 electrons) as follows: $10^{-4} \times 10^{-6} / 1{\cdot}59 \times 10^{-19} \times 10^6 = 630$p/s. This rate of count is within the capacity of a Dekatron so that the dark current can be determined to any degree of precision.

The Dekatron GC10B is limited to a maximum rate of 4kp/s. As the maximum luminescence to be measured amounts to about 100kp/s the rate has to be reduced. This is done by submitting the pulses after amplification

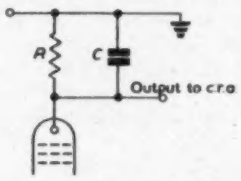


Fig. 1. The basic circuit

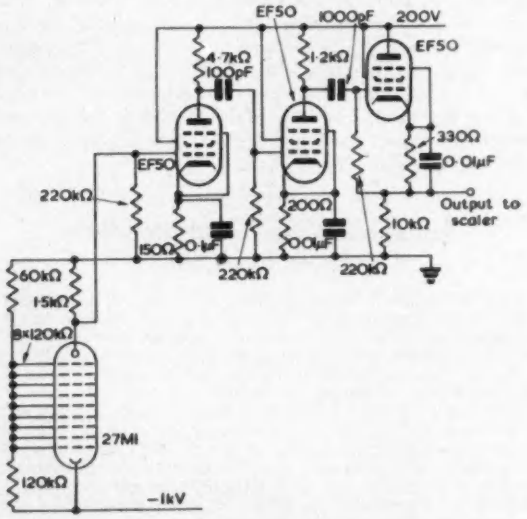


Fig. 2. The photomultiplier pulse amplifier

to a pulse height discriminator, which is set so that the majority of the pulses is not recorded. When the dark current is adjusted to 2p/s the maximum light current is only 300p/s.

The Precision of Measurement

The output pulses of a photomultiplier are randomly spaced. This output may be contrasted with a sine wave whose peaks are spaced at regular intervals. The conse-

* *Nuffield Department of Clinical Biochemistry, the Radcliffe Infirmary, Oxford.*

quence of the random spacing is that a given count only carries with it a probability of precision. Thus in a given second 500 pulses may be recorded; in the next second 540; in the next 485, and so on.

However, the larger the number of pulses that are recorded the greater is the precision of measurement. Suppose in the above example counting was done in intervals of 60sec. Then in the first period 30 000 pulses might have been recorded; in the next period 30 387; in the next 29 910. It is clear that there is much smaller percentage variation in these numbers than in the first series.

The luminescence to be measured is not constant (see below). It is at a maximum at the instant of mixing the reagents and then falls off as they are used up. The measurement is made by counting the pulses for a fixed period. The precision of the count is a function of the number of pulses, and the pulse height discriminator is adjusted so that the count is high enough to be sufficiently precise but not so high that the scaler employed is unable to record them.

The dark current on the other hand is constant—it is a function of the ambient temperature. A high count can be obtained for the dark current by extending the time of measurement: 2p/s is 1 800 per 10 minutes.

The Circuit

The circuit of the pre-amplifier and of the photomultiplier power supply are shown in Figs. 2 and 3. The resistor R in Fig. 1 is given the value of 1·5kΩ; the stray capacitance is kept low, but without taking elaborate precautions. The low frequency response of the amplifier is made sufficiently poor that there is no interference from the 50c/s mains.

The pre-amplifier output was connected to the 'G.M. Tube' input of an Ekco scaler Type N529. This supplies

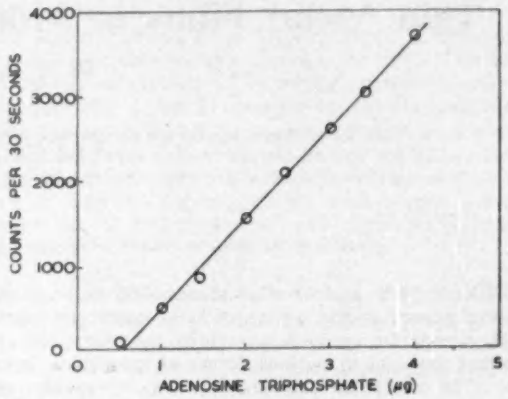


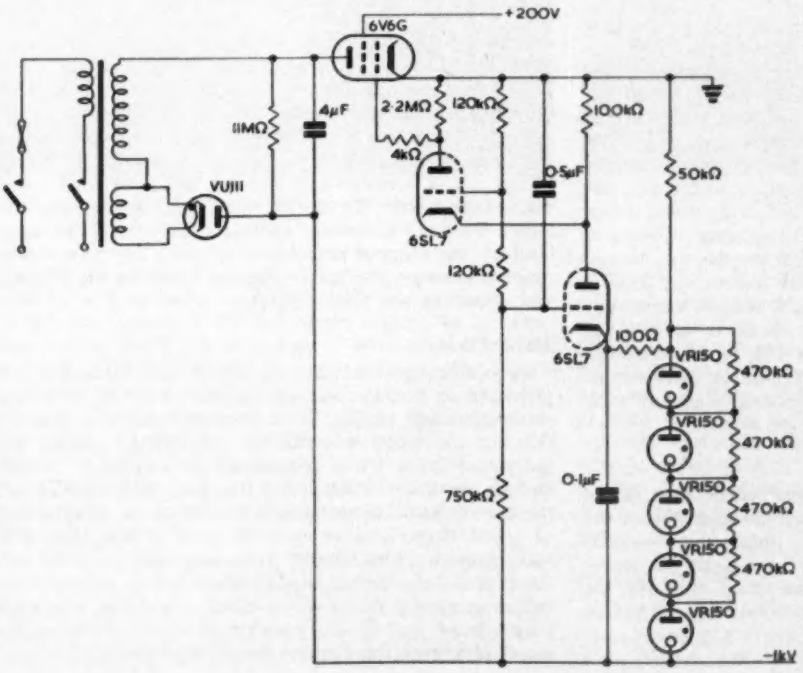
Fig. 4. The calibration curve

an additional stage of amplification (gain 25), before the pulse height discriminator and scaler.

It will be noticed that no capacitors are fitted across the individual resistors in the potential divider chain feeding the 27M1. The maximum pulse is $1{\cdot}59 \times 10^{-19} \times 1{\cdot}95 \times 10^{6} = 3{\cdot}1 \times 10^{-13}$ coulomb, and it passes in 10^{-6}sec: the equivalent continuous current is 31μA. The resistor supplying the penultimate dynode through which most of this current passes has a value of 60kΩ, so the potential difference across it should fall by 1·9V. The total voltage across the 60kΩ resistor is only about 50V, so the pulse might be limited by the voltage drop.

This limitation could be avoided by placing a capacitor across the 60kΩ resistor. The value of the capacitor can now be calculated, assuming that a voltage change of 0·1V can be tolerated. By definition 1 coulomb will produce 1V across the terminals of a capacitor of 1 Farad. So 3×10^{-13} coulomb will produce 0·1V across 0·3pF. As the stray capacitance is likely to exceed this value, no additional capacitance is required.

Fig. 3. The photomultiplier power supply



Measurement of Luminescence

The luminescence to be measured is obtained by mixing an extract of dried firefly lanterns[1] with adenosine triphosphate. The luminescence appears as soon as the mixture is prepared. It decays exponentially with a half-time of about 1·0min, but it can be followed for at least 15min.

A convenient procedure is to start a stopwatch when the mixture is prepared, then to allow 30sec for transferring it to the photomultiplier, and then to count the photomultiplier output pulses for the next 30sec. A calibration curve obtained in this way is shown in Fig. 4.

REFERENCE

1. Strehler, B. L., Totter, J. R. Firefly Luminescence in the Study of Energy Transfer Mechanisms. I Substrate and Enzyme Determination. *Arch. Biochem. Biophys.* *40*, 28 (1952).

Thin Metal Films in Millimetric Wave Measurements

By M. H. Cufflin*, B.Sc.

In a millimetric wave measurement project it was necessary to design some coupling and reflecting disks for use in circular waveguide. The use of evaporated metal films on thin glass disks was investigated and in this article the results obtained are detailed for metal films with and without slots.

(Voir page 831 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 838)

A NECESSARY part of a programme of research and development in the transmission of millimetre waves of H_{01} mode in circular waveguide, was a means of assessing the loss in various forms of waveguide structure. One attack on this problem was to attempt the direct measurement of the attenuation, in terms of decibels per mile, by observations on the decay of a short train of waves reverberating in a length of guide terminated at each end by a short circuit or reflecting plate.

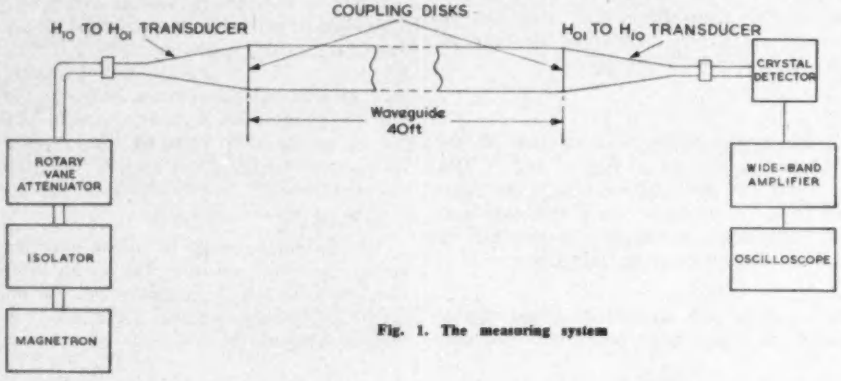


Fig. 1. The measuring system

General Arrangement of Measuring System

The schematic arrangement of the measuring system is shown in Fig. 1. The train of waves was generated by a Q-band magnetron, the peak power being over 20kW with a pulse length of 0·02μsec giving a wave train approximately 20ft long in the guide. The wave train was passed via an isolator and an attenuator to a transducer generating predominantly H_{01} mode waves in a circular guide, 2in diameter. The length of guide under test was closed at each end by coupling and reflecting disks, which will be described in the following paragraphs. Owing to the high power of the initial pulse from the magnetron, it was necessary to protect the crystal detector, by placing it at the far end of the guide, using a further transducer, to reconvert the H_{01} mode to H_{10} mode in rectangular guide. The detector output was fed to a wide-band amplifier, before display on a high resolution oscilloscope. The latter was triggered by the leading pulse of each train of reverberations detected by the crystal.

Initial Observations

Obviously, if the disks were perfect reflectors, it would be impossible for any energy to enter the guide from the magnetron. Initially, coupling was obtained by providing a ring of holes on a pitch circle 0·48 of the waveguide diameter, at the zone of maximum field for the H_{01} mode. The disks were of polished brass, 1/16in thick, and a typical design had 18 holes each 0·150in diameter. It was soon discovered that these introduced many modes and resonances, a typical 'echo' trace from the oscilloscope being shown in Fig. 2, which used 40ft of precision drawn copper tube. The same coupler is shown in use with 40ft of helical wire-wound waveguide in Fig. 3. The rapid attenuation and multiple interference of spurious modes can be clearly seen. The interval between main echoes corresponds to a distance travelled, of 80ft, up and down the guide. For the principal echoes due to the H_{01} mode, the velocity is 97·9 per cent of the velocity of light, and this was used to estimate the distance travelled by echoes in attenuation measurements. Thus 10 echoes represented 784ft and so on. In all the photographs the time scale is the same. Thus, a comparison of the rapidity of attenuation for each arrangement can be readily seen. It should be noted that owing to the use of a square-law detector the pulse decay seen was exaggerated. To avoid error, attenuation was obtained by the well-known method of adjusting the input level by the accurate attenuator to bring the pulse under observation to a standard reference level on the display, and observing the level difference.

Metal Films

It became apparent that the smaller the holes, and the greater their number, the less serious would be unwanted resonances and modes. It seemed reasonable to assume that, in the limit, it would be possible to replace the individual holes by a continuous annular slot. After various methods of achieving this had been rejected for mechanical reasons, the practical solution of using a film of metal evaporated in vacuum on to a thin glass disk was evolved. The annular ring was then cut into this metal film. A number of difficulties had to be overcome before successful slots were obtained. A second approach which grew out of the basic method of obtaining the metal films was the possible use of slightly 'transparent'

* *Marconi's Wireless Telegraph Co. Ltd.*

films, in a manner similar to that used in many optical devices.

Aluminium and gold films were tested. The aluminium films were eventually found to be most satisfactory when a very thin flash of gold was deposited to protect the aluminium surface from oxidation. They would also be slightly cheaper due to the smaller quantity of gold required in the vacuum evaporating chamber.

Use of Transparent Films Without Slots

Estimates showed that with the anticipated losses in the waveguide, it was necessary to keep the loss, due to the escape of energy through the end plates, below 0·25 per cent at each reflection. That is, the energy appearing on the side remote from the source should be at least 26dB below the incident energy. This would be less critical the longer the guide available for test. The thickness required was calculated using Schneider's method[1] and was of the order of 100Å. The thickness was checked by a calibrated optical densitometer. It is of interest that the films transmitted about 30 per cent of light, the gold film being of light green colour by transmitted light. The aluminium film was neutral with a faint tinge of blue.

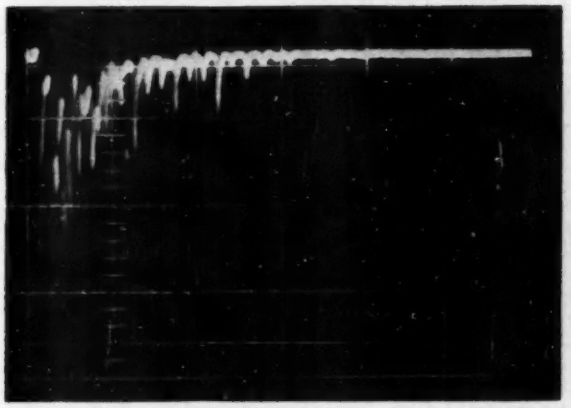


Fig. 2. Solid copper waveguide 2in diameter 40ft long multi-hole coupler each end

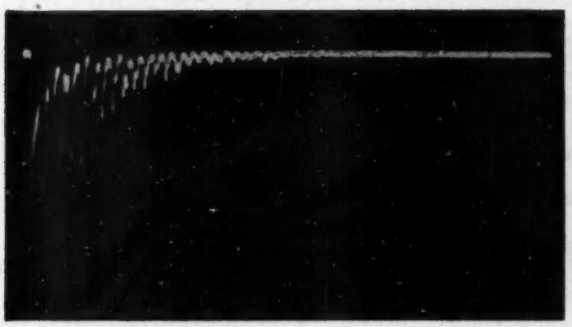


Fig. 3. Helix waveguide 2in diameter 40ft long multi-hole couplers each end

Evidence of the success of these transparent films in their freedom from introducing spurious modes is seen in Figs. 4 and 5 which are, again, 40ft guides of solid copper and helically wound wire respectively. Unfortunately, a high loss was apparent, leading to rapid attenuation of the echoes. This was found to be due to high loss at each reflection, in the film itself, irrespective of the 0·25 per cent passing through the film. The extent of the loss was measured by successive observations with 30ft and 20ft lengths of guide, to extract the 'end effect'. This was typically 0·3dB for each reflection and was too high for tests on 40ft of guide. It was possible to reduce this loss by increasing the film thickness, but the attenuation through the film became too high to give sufficient power for the crystal detector, even with 20kW peak at the source!

Opaque Film With an Annular Slot

Coupling disks were made using metal films at least 1 micron thick, with an annular ring 0·030in wide and 0·96in mean diameter. These were quite opaque to light and were in fact excellent optical mirrors and low loss reflectors for millimetre waves. Echoes obtained are illustrated in Figs. 6 and 7. In these photographs the lower loss on reflection was evident from the larger number of echoes. Spurious mode effects were seen in the non-uniform decay of amplitude as interference occurred between echoes of different velocity. Circular symmetry indicated that these were H_{0n}-modes, with the probability of a considerable level of H_{02}-mode, due to the presence of the slot substantially on a maximum zone for this mode. H_{02}-mode was, conversely, expected to be of low power.

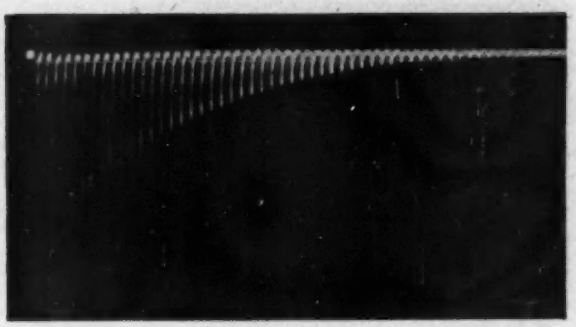


Fig. 4. Solid copper waveguide 2in diameter 40ft long thin film couplers each end

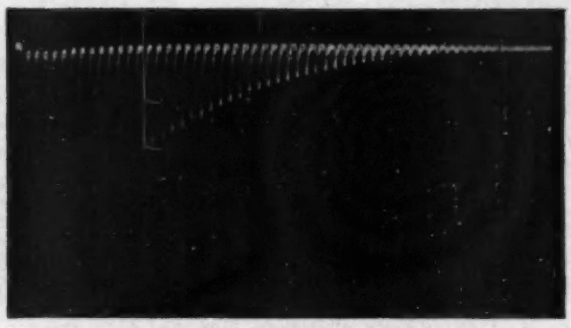


Fig. 5. Helix waveguide 2in diameter 40ft long thin film couplers each end

Opaque Film With Several Annular Slots

With the object of reducing spurious H_{0n}-mode generation, coupling disks were made with several concentric rings, 0·009in wide, and of diameters selected to promote

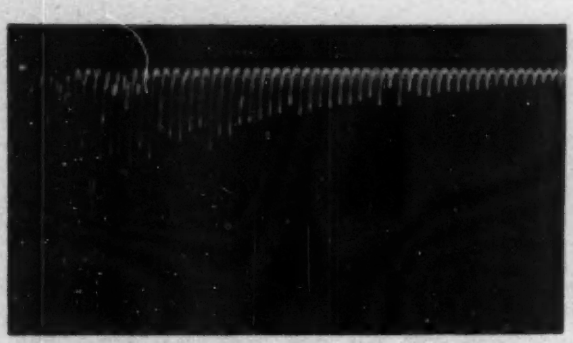


Fig. 6. Solid copper waveguide 2in diameter 40ft long single ring couplers each end

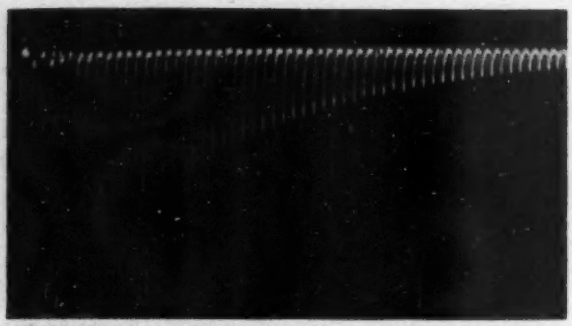


Fig. 8. Solid copper waveguide 2in diameter 40ft long 5 ring couplers each end

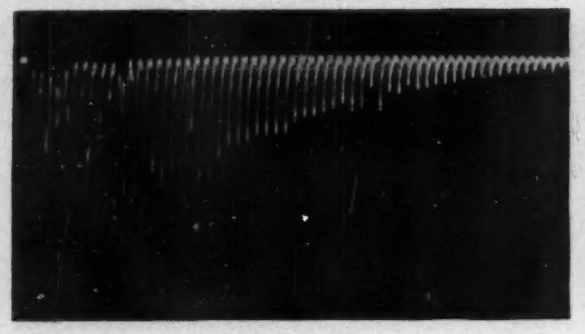


Fig. 7. Helix waveguide 2in diameter 40ft long single ring couplers each end

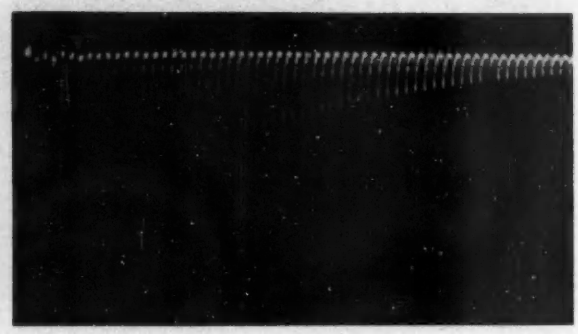


Fig. 9. Helix waveguide 2in diameter 40ft long 5 ring couplers each end

H_{01}-mode, but not other H_{0n}-modes. The performance of such disks is shown in Figs. 8 and 9. The freedom from spurious modes is clear from the smooth decay of the echoes.

Conclusion

Two forms of coupler have been devised which offer useful improvements in measuring techniques for millimetre waves. The semi-transparent film, without slots, should prove useful where an aperiodic coupling is required, at the cost of some surface losses. The high reflection film offers a means of achieving special dispositions of slots to obtain particular performances, in a way difficult or impossible to achieve by built-up metal parts. Combinations of various films and both annular and radial slots should find application in mode filters peculiarly adapted to circular waveguide transmission.

Acknowledgments

These thin film applications were devised by a team including the author, and Messrs. E. F. Schelisch, J. A. Berry and R. E. Howick of the Research Laboratories of Marconi's Wireless Telegraph Co. Ltd. who were assisted by the Company's Vacuum Physics Group in preparing the films and by the Research Model Shop in achieving clean and accurate slot-cutting by inexpensive means.

This article is published with the kind permission of the Engineer in Chief, Marconi's Wireless Telegraph Co. Ltd.

REFERENCE

1. SCHNEIDER, M. Properties and Applications of Thin Metal Films in the Microwave Range. *Tech. Mitt. PTT. 37*, 465 (1959).

Fast Ferrite Memory Systems

The award of a £450 000 contract for ferrite memory systems from Ferranti Limited and the recent establishment of a production unit for these systems marks the successful conclusion of a stage in the development of this equipment by The Plessey Company Limited.

Basic research into the employment of the two ferrite cores-per-bit technique for computer high-speed storage systems was initiated by Plessey at their Roke Manor Research Laboratories in 1958.

The team at Manchester University, under Prof. T. Kilburn, was also working on two cores-per-bit techniques as part of that university's programme for an advanced design aimed at the development of MUSE. When Ferranti joined forces with Manchester University to develop 'Atlas', the first orders for memory systems were placed with Plessey.

The Plessey research team, under the direction of Dr. G. B. B. Chaplin, technical manager of the Roke Manor Laboratories, and led by Mr. W. Renwick, had to design an 'index' store with a capacity of 128 words 25 bits and a cycle time of 0·5μsec and a 'working' store of 1024 words 50 bits with a cycle time of less than 2μsec. Close co-operation was established right from the beginning with the team at Manchester University and advantage was taken of their tremendous experience in actual computer operating conditions.

The Memory Group of Plessey Electronic Laboratories at West Leigh then developed and engineered the initial production version of the 'index' store for the first 'Atlas', which is being installed at Manchester University.

An extensive design programme for the 'working' store was initiated in April 1960. Early in the year an improved ferrite core material had been developed by Plessey which enabled the working store cycle time specification to be met without resorting to the more costly two cores-per-bit system although it necessitated the introduction of special matrix wiring. The prototype was installed at Manchester by September, when tests proved that these new basic principles were sound. The team at West Leigh then produced an engineered model.

Developed from the 1024 word 'working' store are the 4096 word 50 bit 'main' store units with a cycle time of 2μsec.

Short News Items

The Committee on the Applications of Electricity in Aircraft jointly organized by the Institution of Electrical Engineers and the Royal Aeronautical Society is arranging a Conference on the Importance of Electricity in the Control of Aircraft. The subject matter will be sufficiently wide to interest aircraft and equipment designers and specialists in all fields of aircraft electrical and electronic development. The emphasis will be on system design and methods of achieving the required reliability for these systems, this being one of the major problems facing the aircraft electrical industry.

Further details of the programme and registration forms for the Conference will be available shortly and may be obtained on application to the Secretary of the Institution of Electrical Engineers, Savoy Place, London W.C.2.

The British Nuclear Energy Society is to be formed on 1 January 1962 and will succeed the British Nuclear Energy Conference which was established in 1955 by the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Electrical Engineers, the Institute of Physics and the Institution of Chemical Engineers, who were joined later by the Iron & Steel Institute, the Institute of Metals, the Institute of Fuel and the Joint Panel on Nuclear Marine Propulsion.

The Institution of Civil Engineers has made its premises in Westminster available as a meeting place, and a regular programme of papers, lectures, symposia and informal discussions is being planned.

The British Scientific Instrument Research Association of South Hill, Chislehurst, Kent, is releasing for general publication a research report entitled 'D.C./A.C. Convertors for D.C. Amplifiers' by E. Komolibus. All known types of d.c./a.c. convertor are covered, and data is given on all convertors commercially available in the U.K. The report comprises 130 pages including 70 pages of circuits and diagrams and 144 references. (Price £2 2s. in U.K.)

The International Association for Analogue Computation (AICA), the French Association of Automatic Control (AFRA) and the French Association for Computation and Data Processing (AFCALTI) are planning to arrange in Paris, from 28 May to 1 June 1962, a colloquium on the techniques and applications of electronic computation in industrial automatic control.

Intending authors are invited to submit a summary of their proposed papers before 15 December to the French Association of Automatic Control (AFRA) at 19 Rue Blanche, Paris 9.

The Swedish market for the British electronic industry has been under investigation by a joint study group which is now preparing to embark on the first of its joint promotional activities.

This is to take the form of a symposium lasting two days and to be held in Stockholm in the early part of 1962. The symposium will cover aspects of interest to component manufacturers and instrument makers. The possibilities of this being undertaken in conjunction with other events is at present being investigated.

The formation is accordingly now announced of the Anglo-Swedish Electronics Marketing Group, to be known as the ANSELM Group; this will replace the former study group.

The founder members of the Group include subsidiaries of British manufacturers and Swedish distributors of British electronic products. Its purpose will be to carry out agreed programmes of joint promotion of British electronic products on the Swedish market; their aim will be to result in bigger sales and a better share of the market. As such they will follow up and complement the promotional work already undertaken in this market by R.E.C.M.F., who have signified their support of the Group and its declared programme.

Mr. J. H. Buss, managing director of AB Solartron, has been elected the first chairman of the ANSELM Group; the marketing adviser is Mr. C. K. Squires and the secretarial offices of the group are at C. K. Squires International Marketing & Economic Research, Kungsgatan 65, Stockholm C.

G.E.C. (Telecommunications) Ltd, and G.E.C. (Electronics) Ltd are two new operating companies which have been formed by The General Electric Company Ltd to take over the activities of the Company's Telecommunications Group.

Co-ordination and direction of these companies will be undertaken by a newly formed holding company, G.E.C. (T & E) Holdings Ltd. The holding company will also be responsible for co-ordinating and directing the activities of the following subsidiary companies: The M-O Valve Co. Ltd, Salford Electrical Instruments Ltd, Watson & Sons (Electro-Medical) Ltd, Machlett X-Ray Tubes (Great Britain) Ltd, and of the G.E.C. Semiconductor Division.

The headquarters of G.E.C. (Telecommunications) Ltd will be at G.E.C. Telephone Works, Coventry, and of G.E.C. (Electronics) Ltd at Union Works, Wembley. The main production units of G.E.C. (Electronics) Ltd will be at Spon Street and Ford Street, Coventry, Broad Oak, Portsmouth, and Union Works, Wembley.

A new company, G.E.C. (Engineering) Ltd, has also been formed to take over and develop the engineering activities of The General Electric Co. Ltd.

The manufacturing resources of the new company comprise the Electrical Engineering Works at Witton, Birmingham, and the Mechanical Engineering Works at Erith, Kent.

The Crown Agents for Overseas Government and Administrations, acting on behalf of The Port of Bahrein Authority has placed an order with Cossor Communications Co. Ltd for a series 121 v.h.f. transmitter for operation in the international maritime v.h.f. band.

The new installation will be used by the Port Authority to control marine

BINDING OF VOLUMES

Readers can have their copies of ELECTRONIC ENGINEERING bound, complete with index and with advertising pages removed, in a good quality red cloth covered case, lettered in gold on the spine, at an inclusive cost of 27s 6d per volume.

Home and Overseas readers who require their issues for 1961 bound are asked to comply with the following instructions:

Tie the issues together, enclose a remittance of 27s 6d with sender's name and address, and despatch in closed parcel to: The Circulation Dept. (E.E. Binding), 28 Essex Street, Strand, London, W.C.2.

(Cheques or postal orders should be made payable to Morgan Brothers (Publishers) Ltd.)

* * *

The following will also be available from our Circulation Dept.:

Complete bound volumes for 1960, price £3 5s 0d post free

Cases for permanent binding of volumes, price 7s 6d each postage 9d.

* * *

The index for Vol. 33 (1961) is bound in with this issue.

traffic using the harbour. In addition, public correspondence channels will enable ships' passengers and crews to be connected with subscribers to the Bahrein Public Telephone System.

The series 121 transmitter is frequency modulated and provides up to six closely spaced channels within the 71·5 to 174·0Mc/s band. The transmitter can be switched to high or low power, when r.f. power output is 50W or 0·5W respectively.

The British Broadcasting Corporation has placed an order with Marconi's Wireless Telegraph Company Ltd for the supply and installation of ten high-power (250kW) short-wave sound broadcasting transmitters of a new type which, when they come into service, should very materially improve overseas listeners' reception.

Six of these transmitters will be installed at the 'Voice of America' relay station at Woofferton. Two more will go into service at the BBC station at Rampisham and the remaining two at Daventry.

The transmitters are specially designed to combat the ever increasing amount of interference experienced by overseas listeners on the short waves. This is achieved by employing a method of modulation which cuts through the interference to bring the signal to the listener. Intensive experiments have shown that the use of this trapezoidal modulation, as it is called, gives an intelligibility at the receiving end which could only otherwise be brought about by more than doubling the transmitter power—that is, in this instance, from 250kW to 550kW.

The main valves, which are of English Electric Valve Company manufacture, are vapour cooled. The overall efficiency of the new type of transmitter is approximately double that of the older equipments supplied to Rampisham and Daventry.

Elliott Brothers (London) Ltd, a member of the Elliott-Automation Group, is supplying radar, computing and control equipment for prototypes of 30mm light anti-aircraft gun mountings which the Federal German Republic has ordered from the Hispano Suiza Company of Switzerland. The entire radar and computing equipment, which performs the same functions as the two to three trailer caravans which are conventionally used to house this type of equipment for A.A. gun sites, occupies a space approximately equivalent to that of a suitcase. It is thus sufficiently compact to be mounted on the turret of tracked vehicles. This has made possible the development of light mobile A.A. gun carriers in which the crews are protected, as in a tank.

Brush Electrical Engineering Co. Ltd, a subsidiary company of Hawker Siddeley Industries Ltd, has received a contract from the GPO to supply control equipment, motors, generators, and servo equipment for a steerable aerial now under construction at the Goonhilly Downs Post Office Radio Station in Cornwall. The Electronics Division of Whitworth Gloster Aircraft, another subsidiary company, is building some of the digital electronic equipment.

The 85ft diameter steerable, paraboloid aerial is similar in principle to the one at Jodrell Bank. It will be used in tracking radio communication satellites in a joint GPO/American experimental programme scheduled for next year. In these experiments, known as Projects RELAY and TSX, American satellites will be used to transmit speech, telegraphy and television across the Atlantic.

Brush were also responsible for supplying all the motive power equipment for the Jodrell Bank radio telescope.

A Symposium on Information Theory, sponsored by the Professional Group on Information Theory of the Institute of Radio Engineers, and organized by the Benelux Section of the I.R.E. and the Belgian Society of Telecommunication and Electronics Engineers (S.I.T.E.L.) is to be held in Brussels, Belgium on 3 to 7 September 1962. Intending authors are asked to forward 500 to 1000-word abstracts of their proposed papers before 15 January 1962 and the complete papers before 15 April 1962 to the Chairman of the Organizing Committee, Dr. F. L. Stampers, Philips Research Laboratories, Eindhoven, Holland.

The Design and Use of Microwave Valves is the subject of a conference being organized by the Electronics and Communications Section of the Institution of Electrical Engineers, and will be held in September 1963 at the I.E.E. headquarters at Savoy Place, London W.C.2. It is proposed to associate a scientific exhibition with the Conference.

The Conference will be organized so as not to clash with the series of international conventions on microwave valves, the next of which will be held at Delft, Holland, in 1962.

Papers are now invited from prospective authors by the Organizing Committee which has been set up under the chairmanship of Mr. A. J. Young, C.B.E., B.Sc.(Eng.), M.I.E.E., and further information may be obtained from the Secretary of the Institution of Electrical Engineers, Savoy Place, London W.C.2.

Wandsworth Council have installed a modern Digital Weighing Information System to speed up the Borough's refuse collection.

The new installation records and analyses details of vehicles emptying their loads—vehicle identification, weights of refuse carried, times of weighing etc.—and reduces subsequent clerical work to a minimum.

The data is automatically punched into tape, and fed into a tape-to-card convertor. The punched cards are then put through a tabulator to produce a record of each individual weighing. Subsequent analysis enables payment to be made according to the tonnage collected.

The equipment was designed and manufactured by Digital Engineering Co. Ltd, Battersea Park Road, London, S.W.1.

Marconi's Wireless Telegraph Co. Ltd have been awarded a contract by the Ghana Posts & Telegraphs authorities for the supply and installation of a twin-path v.h.f. multi-channel radio telephone system to link the Volta River Dam area with Accra, the capital. The carrier equipment will be provided by the Automatic Telephone & Electric Company Ltd.

The route, which was surveyed by Marconi's under a separate contract, will run from Accra to Tema and then to Akosombo, where the dam is being built. The product is expected to be complete in the spring of next year.

Present-day and future weapons and equipment were included in a demonstration organized by the War Office and held at The Fighting Vehicles Research and Developmeent Establishment at Chobham, Surrey, on 24 to 27 October.

Code-named 'Argus' the demonstration consisted of a display of tracked and wheeled military vehicles including those which are already in service with the Army or are undergoing further development.

A wide range of communication equipment carried by the various types of vehicles was also on display together with computer equipment and the latest types of multi-channel transistorized radio relay link apparatus.

A speaking clock, which is the first of a new type, has been ordered by the Sudanese Government for operation with four telephone exchanges which have been manufactured and installed by AEI Telecommunications Division.

Although providing only a bi-lingual service for the Sudan, the clock is capable of announcements in as many as five different languages.

The speaking clock employs a tape recorder which is controlled by pulses from an accurate, crystal-controlled chronometer which is an integral part of the equipment. It ensures a maximum time variation over a period of a month of less than a second.

J. Langham Thompson Ltd, of Bushey Heath, Hertfordshire, have concluded an

exclusive licence agreement with Hastings-Raydist Inc., Hampton, Virginia, U.S.A., under which J.L.T. will market and subsequently manufacture the full range of Hastings-Raydist vacuum gauges, altimeters, air velocity instruments, flow meters, 'electroverters', thermal conductivity gauges, etc. Initially J.L.T. will stock vacuum gauges and first supplies will be available shortly.

Dawe Instruments Ltd have assumed responsibility for the export sales of equipment by Cawkell Research & Electronics Ltd. This move is part of the planned reorganization programme following the entry of both firms into the Simms Group about a year ago. The production of Cawkell equipment has already been integrated with that of Dawe at their factory at Western Avenue, Acton, London, W.3.

Racal Electronics Ltd (formerly Racal Engineering Ltd) of Bracknell have announced the formation of Racal (Australia) Pty. Ltd to be responsible for marketing Racal and other products in the Commonwealth of Australia and mandated territories.

The new Company will work in close co-operation with Commonwealth Electronics Pty. Ltd of Baulkham Hills, Sydney, who have made accommodation available to Racal.

Storno-Southern Ltd, of Camberley, Surrey, have installed f.m. transistorized radio-telephone equipment in the Manchester Minicab fleet.

A 25-watt base station at the Minicabs' operational headquarters at Gorton, in Manchester, feeds a standard centre-fed dipole aerial mounted on an 80ft mast.

The fleet at present consists of thirty-five B.M.C. Miniminor cars.

Brazilian Trade Consultants, associated with Administradores Profissionais Associados of Sao Paulo, Brazil, offer their specialized services to British companies interested in having their products manufactured in Brazil, either under a royalty agreement, in partnership with a local concern or by establishing their own subsidiary in that country. The Principal of Brazilian Trade Consultants, Mr. Gordon B. Coleman, is at present in the United Kingdom at 17 Farm Avenue, North Harrow, Middlesex (Tel: Field 9951).

Johnson, Matthey & Co. Ltd have acquired the majority of the shares of the leading Belgian precious metal company, Pauwels Freres S.A. The future name of the Belgian company will be Johnson Matthey & Pauwels S.A. Since 1956 Johnson Matthey have acquired manufacturing and trading interests in France, Holland, Italy and Sweden.

The Council for Scientific and Industrial Research has appointed Dr. John Vernon Dunworth, C.B.E., as Deputy Director, National Physical Laboratory, D.S.I.R., in succession to Dr. G. Macfarlane, who is shortly to take up the appointment of Director of the Royal Radar Establishment, Malvern. Dr. Dunworth is at present Deputy Director of the Atomic Energy Establishment, Winfrith.

Electrosil Ltd has recently been formed to manufacture and sell a range of metal oxide film resistors originally developed in the U.S.A by Corning Glass Works. The Company has been formed by Corning in association with James A. Jobling Ltd. The manufacturing plant is in Sunderland.

Full details of Electrosil resistors and special duty components are available from Electrosil Ltd, Colnbrook By-Pass, Colnbrook, Slough, Buckinghamshire.

A new research laboratory has recently been established by The American Machine and Foundry Co. at Blounts Court, Peppard, near Henley-on-Thames. Its main purpose will be to undertake long range research in those fields of science which relate to AMF's industrial activities.

Other subjects of this laboratory will be to provide a team of scientists who can act in a consulting capacity to AMF's British and European companies and to serve as an information and liaison centre in Europe for AMF's Research and Development Division in the United States. The new Director of Research will be Dr. D. A. Bell, formerly of the Electrical Engineering Department of the University of Birmingham.

Communications (Air) Ltd, a member of the A. C. Cossor Group of Companies, announce a new v.o.r./i.l.s. signal simulator which will enable users to comply with relevant A.R.B. recommendations.

The new equipment, Field Test Set Type FT 13 C, is similar to its predecessor, Type FT 13 B, an automated equipment which enables a semi-skilled technician to check an aircraft v.o.r./i.l.s. installation, in situ, in approximately ten minutes. Type FT 13 C, however, provides 1° change in v.o.r. bearing, in accordance with current A.R.B. recommendations. This new facility is available on manual control only.

British Communications Corporation, a subsidiary of Radio and Television Trust, has recently obtained a large contract for the supply of v.h.f. radio transmitter/receivers type A.40 to the British Army.

B.C.C. are also supplying the British Army with h.f. man-pack sets type H.F. 156, and mobile radio equipments type W.S. C.13 for use in tanks and armoured fighting vehicles.

The H.F.156 is established as the standard military man-pack set in more than a dozen countries.

The French Aviation Authorities have selected the Pye Instrument Landing System, incorporating a directional localizer, for installation at their research and development centre at Bretigny, near Paris, where work on military and civil aircraft landing systems is carried out.

Pye Telecommunications Ltd, of Cambridge, England, have now supplied over 135 instrument landing systems which are in use throughout the world.

Airborne weather radar type E190 has been ordered from Ekco Electronics Ltd by Short Brothers and Harland Ltd for installation in ten of their new Belfast air freighters. This equipment employs a dual transmitter/receiver and indicator system, in keeping with the current practice of duplicating essential services which are the subject of mandatory requirements.

Ekco airborne weather radar is also to be installed in the de Havilland Comet 4 airliner recently ordered by King Saud of Saudi Arabia.

The Electrical Research Association has issued a report V/T133 entitled "An audio-frequency Buffer Amplifier with Isolated Output" by P. S. Kendall and A. B. Sylvester.

The report describes an amplifier developed for use in the generator units of the E.R.A. network analyser which are required to provide an undistorted output of very low impedance, isolated from earth, and capable of supplying a wide range of loads. Copies of the report are obtainable from the Electrical Research Association, Cleeve Road, Leatherhead, Surrey, price 7s. 6d., postage 6d.

The North East Derbyshire Joint Water Committee have recently ordered from Murphy Radio Ltd, Radiotelephone Division, at South Ruislip, Middlesex, a base station transmitter-receiver and mobile equipment for use in the Committee's area. The scheme will be remotely controlled, and the base station is engineered for automatic changeover in the event of GPO landline failure.

LETTERS TO THE EDITOR

(We do not hold ourselves responsible for the opinions of our correspondents)

The Theory of Negative-Feedback Voltage Amplifiers

DEAR SIR,—May I please make the following points concerning the recent correspondence[1] on my article[2] on the theory of negative-feedback voltage amplifiers.

(1) To obtain the utmost possible accuracy under any circumstances, the mesh equations must be used, taking account of all actual components and all known strays.

(2) The problem may be simplified to one of an open loop, while still retaining an extremely high order of accuracy (much higher than the quantities concerned can be known to, in most practical cases) by using the method of the article, in which the input impedance of the attenuator is considered to be replaced by that of a dummy load. This was stated right at the beginning of the article to be an assumption or approximation, although a very accurate one in practice. For example, in the case of the anode-cathode follower circuit[3], taken by Mr. Deards to demonstrate the inaccuracy of the method, the error in α amounts to 1 part in 90 000, which corresponds to 1 part in 6 000 000 in the overall gain.

(3) This result is not fortuitous but is a logical outcome of reasoning based on the low output impedance of a negative-feedback voltage amplifier, its corresponding insensitivity to loading effects, the low input admittance which is normally provided in designing the attenuator, and the fact that the term omitted by the approximation only amounts to a small fractional change in the latter (of order $1/\alpha$, at most).

(4) If one is not prepared to neglect any conceivable term, however small, Mr. Deards' modification of my method is open to exactly the same objection of principle as the one alleged against the original method. His method, in effect, replaces the input impedance of the amplifier by an appropriate dummy load, assuming that this input impedance is constant and that there is absolutely no transfer of signal through the amplifier from the output end to the input. This is not always true, especially for triode or transistor amplifiers, and consequently the input admittance of the amplifier is, strictly speaking, a function of the input admittances presented to its output by the external load and the attenuator.

(5) If one is prepared to omit terms representing really negligible sources of error, which one must inevitably do at some stage (one does not allow for strays in every component, for example) the method of the article stands as both simple and precise. Mr. Deards' modification adds appreciably to the complexity but not to the accuracy.

Yours faithfully,

C. H. VINCENT,
U.K.A.E.A., Aldermaston,
Berkshire.

REFERENCES

1. VINCENT, C. H. The Theory of Negative-Feedback Voltage Amplifiers. (Letters to the Editor) *Electronic Engng. 33*, 746 (1961).
2. VINCENT, C. H. The Theory of Negative-Feedback Voltage Amplifiers. *Electronic Engng. 33*, 442 (1961).
3. VINCENT, C. H., KAINE, D. The Anode-Cathode Follower. *Electronic Engng. 32*, 242 (1960).

The Correspondent Replies:

DEAR SIR,—My replies to the five points of Dr. Vincent's letter are as follows:

(1) We do not analyse the physical system but an abstracted mathematical model called an electric network. The accuracy of the analysis depends upon the correspondence between the network and the physical system and not upon the method of analysis. Once a satisfactory network representation is established there exists a unique mathematical expression of its behaviour and the purpose of network analysis is to determine this expression. Several techniques are available including the use of mesh equations. If Dr. Vincent cares to analyse the network representation in Fig. 4 of his article according to any of these techniques he will obtain the gain and output impedance expressions given in equations (2) and (3) of my letter.

(2) If α is correctly defined, Dr. Vincent's method provides absolute mathematical accuracy. I can find no statement in his article explaining that the use of the dummy load is an approximation. The only remark I can find is that the impedance presented by the attenuator is assumed to have a known constant effective value. In the examples of his article and my letter, this assumption is unnecessary; in each case this impedance has a known constant effective value but the method yields results different from those obtained by other methods of analysis.

(3) The method leads not only to omitted terms but to spurious terms as in the denominator of his expression for the gain of the 'anode-cathode follower'.

(4) For a given network representation of a physical system, the method recommended in my letter yields exactly the same results as a mesh, cut-set, or node analysis. A dummy load is not employed. As is customary in network analysis, the valve interelectrode capacitances (impedances in general) are represented as passive elements external to the ideal valve. The loop is opened 'behind' these capacitances at the grid of the first valve so that the input admittance is zero and conditions remain unaltered when the loop is closed. Since the grid-anode capacitance becomes part of the feedback network, reverse transmission by this capacitance is taken into account. If a pair of terminals of zero admittance cannot be found (as might be the case when all the amplifier valve grids are in conduction) then open-loop methods of analysis cease to be applicable because the state of the system changes when the loop is closed. This is generally so for transistor systems.

(5) I am unable to agree that Dr. Vincent's method is precise unless α is defined as the closed-loop gain. I am also unable to agree that the method of my letter is no more accurate than that proposed by Dr. Vincent. Equation (6) of my letter is an expression of closed-loop equilibrium. The factors α, β, γ and δ have the same interpretation in application as in the development of the equation. Equation (2) of Dr. Vincent's article is also an expression of closed-loop equilibrium. The factors γ and β have the same interpretation in application as in the development of the equation but α has not. In the development of the equation it is the gain with the feedback operative but in application it is the gain with the feedback inoperative. It is for this reason that the method yields equations with omitted and spurious terms.

Yours faithfully,

S. R. DEARDS,
The College of Aeronautics,
Cranfield, Bucks.

The Author Replies:

DEAR SIR,—Mr. Deards claimed that the method of my article is 'incorrect', but he failed to demonstrate any serious lack of precision. He then alleged that the approximation was made without stating it to be one, but in the first paragraph is the statement "This is true to a high degree of accuracy in almost all practical cases". (I do not think that your readers will have any difficulty in deciding for themselves, in practice, when they can say that the effective impedance of the attenuator is known in advance to a sufficient degree of approximation, because it leads only to a high impedance grid, or to a virtual earth or other points at a low signal voltage compared with the output voltage.) Mr. Deards now introduces a new rule, which is, in effect, that once components have been shown in a circuit diagram, it is not permissible to make a mathematical

approximation based on their known high or low values in normal cases of interest. I am happy to leave this rule to the judgement of your readers.

Yours faithfully,

C. H. VINCENT.

This correspondence is now closed.—EDITOR.

A Transistorized Ring Counter

DEAR SIR,—Mr. P. J. Westoby has described[1] a ring counter using valve trigger pairs in which the output of one trigger pair is capacitively coupled to the relevant input of the next trigger pair. By virtue of this capacitive coupling the application of drive pulses to one side of each and every trigger pair results in the shift of a dissimilar state from stage to stage. Each binary variable, either 0 or 1, may be extracted from each stage of the ring thereby facilitating the operation of external logic circuits.

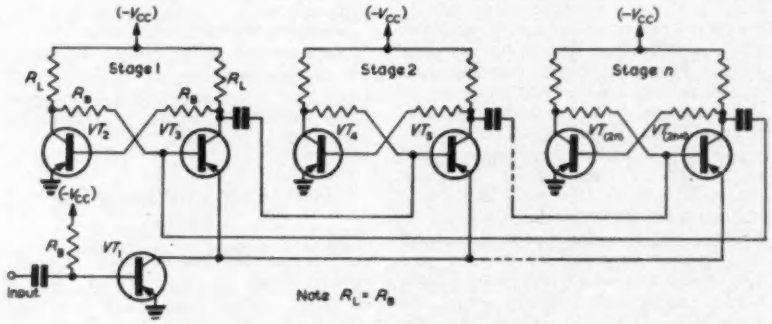


Fig. 1. A transistorized version of the counter

Fig. 1 shows the circuit diagram of a transistorized version of this counter which capitalizes on the characteristics of the SA.496 transistor. Note that with the directly coupled techniques made possible with this particular transistor few components are used in a relatively uncomplicated circuit and the drive transistor. VT_1, has only to switch off one transistor within the ring no matter how many stages are used. This latter characteristic leads to considerable economy in drive power for large rings, when compared with more conventional methods. Note also that the use of this low leakage silicon transistor permits the use of comparatively high valued collector load resistors, yet at the same time, permits operation over a wide range of temperature. The circuit is very tolerant to supply voltage changes and the value of the collector load and base coupling resistors —in fact it may be considered usual to use only one value of resistor throughout the whole counter.

The counter may be cleared by applying a long pulse (longer than the internal *CR* times) to the base of the drive transistor or to the base of a further transistor in series with VT_1 in which case all the trigger pairs within the ring are set to '0' and then using the back edge of this pulse to set a '1' in the desired counter stage by either capacitor or transistor coupling. Other methods suggest themselves.

The writer would like to acknowledge the work carried out by Mr. D. J. Bradley of this laboratory, who has constructed a number of these counters and carried out many tests.

Yours faithfully,

J. W. RINGROSE,

Applications Laboratory,
Semiconductors Ltd,
Swindon.

REFERENCE

1. WESTOBY, P. J. A New Type of Ring Counter. *Electronic Engng. 31*, 375 (1959).

Derivation of a Mean Frequency

DEAR SIR,—The circuit in Fig. 1 was devised to extract a sinusoidal signal whose frequency is the mean of two input frequencies and whose phase bears a fixed relation to the mean phase.

The two frequencies, f_1 and f_2 are fed into the balanced modulator and low-pass filter network as shown, the amplifier and controlled oscillator completing a phase-lock loop. In the steady state $f_1 + f_2 - 2f = 0$ and, therefore, f equals the mean frequency.

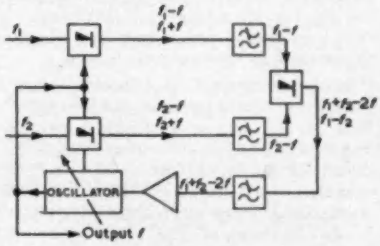


Fig. 1. Arrangement of the circuit

Yours faithfully,

D. FRANKLIN AND W. R. WORDEN,

E.M.I. Electronics Limited,
Wells, Somerset.

An Improved Driving Circuit for a Diode Limiter

DEAR SIR,—As admirably stated in the communication from Messrs. E.M.I. Ltd in your November issue[1] the diode limiter, for satisfactory efficiency, must be supplied through an impedance which is effectively high compared to the diode impedance.

An ordinary tuned or tank circuit presents a high impedance at carrier frequency but a low impedance at harmonic frequencies. A single harmonic-stop circuit gives a great improvement; this was discussed previously[2] and the Fourier series associated with such devices were investigated theoretically by us[3].

However, as shown[4], a coupled circuit may be correctly described as an impedance invertor or quarter-wave circuit. Such a circuit fed from a high-impedance source as in Fig. 3 of reference 1 gives a low output impedance and is therefore quite unsuitable for feeding a diode limiter. At least two constraints are desirable to secure good limiting[2]; our circuit (Fig. 2, reference 1) provided high impedance to both fundamental and second (or third) harmonic.

Yours faithfully,

C. G. MAYO AND J. W. HEAD,

B.B.C. Research Department,
Tadworth, Surrey.

REFERENCES

1. An Improved Driving Circuit for a Diode Limiter. *Electronic Engng. 33*, 739 (1961).
2. HEAD, J. W., MAYO, C. G. Combined Limiter and Discriminator. *Electronic Radio Engr. 35*, 85 (1958).
3. MAYO, C. G., HEAD, J. W. Fourier Series Associated with Duty Cycles. *Brit. J. appl. Phys. 11*, 103 (1960).
4. MAYO, C. G., HEAD, J. W. The Foster Seeley Discriminator. *Electronic Radio Engr. 35*, 44 (1958).

A 100c/s Counter for Registering Small Time Intervals

DEAR SIR,—Referring to my article published in the September 1961 issue, it has been observed that the operation of the gate contacts as shown in the circuit sometimes introduces a random signal into the counting tube circuits. This effect had been noticed before during the early stages of development of the counter but appeared to clear itself subsequently. It has been found possible to clear the trouble by including a 10kΩ resistor in series with the gate lead to the suppressor grid, this resistor preventing interference from unwanted signals probably due to the discharging of the suppressor grid circuit capacitance to earth, and the actual closing of the gate itself, depending on the type of gate contacts used. In one instance examined, resistors between 5kΩ and 15kΩ inclusive were found to be satisfactory.

Yours faithfully,

P. DAWE,

University of Oxford.

EE 40 133 for further details

Announcing

The Marconi *Series Covering Advances in Radio and Radar*

The first volume published by Van Nostrand is

Ferrites: an Introduction for Microwave Engineers

R. A. WALDRON, *Section Chief, Mathematics & Systems Analysis Research Group, Marconi's Wireless Telegraph Company.*

This book introduces the basic theoretical principles of ferrites, with a supplementary discussion of applications. In view of the very great interest in this new subject, and the absence of other books covering the same ground, FERRITES will be of considerable interest to new workers, including physicists, electrical engineers and mathematicians, designers and research workers.

6 x 9 inches, 256 pages, 100 illus. 50*s.*

VAN NOSTRAND

385, Kensington High Street, London, W.14.

BOOK REVIEWS

Nuclear Pulse Spectrometry

By R. L. Chase. 221 pp. 109 figs. Medium 8vo. McGraw Hill Book Co. Ltd. 1961. Price 66s.

MANY types of nuclear radiation detector give out a signal consisting of a pulse of electric charge whose amplitude is proportional to the energy dissipated in the detector and whose time of occurrence is of significance to the experimenter. After the charge pulse has been processed by some kind of amplifier and shaper, the amplitude may be measured and the time of occurrence recorded. In any practical experimental arrangement a wide range of pulse heights may be encountered simultaneously with the distribution in time.

The book deals with the analysis of the amplitude and time spectra of such signals. The author is well known in the field and has made significant contributions over the past few years and has produced a volume whose objective is 'to acquaint practising experimental nuclear physicists with the capabilities, limitations, operating principles and future prospects of counter instrumentation; to introduce electronic design engineers to some of the problems of nuclear circuit design in order to encourage their interest and participation in future developments; and to present, in a single volume, a study of the present status of nuclear pulse-height and pulse-time-distribution spectrometers.'

The general organization of the material is well adapted to the above aims. The first two chapters give general ground work on the characteristics of radiation detectors and on the fundamental electronics of linear amplifiers and pulse shaping networks. Chapter 3 deals with single channel pulse height analysers which measure the number of pulses having an amplitude lying within a 'window'. A spectrum may then be plotted point by point by varying the threshold voltage corresponding to the bottom of the window. Dr. Chase deals mainly with thermionic valve circuits for this application and makes no mention of the various mechanical sweeping devices which are commonly used in order to plot out the spectrum on a recorder. Chapters 4 and 5 deal with multi-channel pulse height analysers and much more attention is paid to transistor circuits. Chapter 4 studies amplitude to digital conversion systems in some detail, while Chapter 5 is concerned with data storage systems including magnetic core memories, cathode-ray tube memories of the Williams type and barrier grid storage tubes. Some acquaintance with elementary computer terminology would be helpful to the reader of these chapters. A short Chapter 6 deals with photographic pulse height analysers in which a photographic record is made of the complete spectrum by the use of a grey wedge and which represents a technique particularly useful for the laboratory unable to afford the relatively expensive electronic multi-channel analysers.

In many of the multi-channel analysers an amplitude to time convertor is used in order to obtain digital amplitude signals. Chapter 7 deals with the converse problem of time analysers, some of which operate by converting time lapse to signal amplitude. Since many of the problems involved in time analysis require the identification of coincidences between signals, about half the chapter is devoted to coincidence circuits.

In more complex experiments, amplitude time correlations and the registration of coincidence amplitudes may be required, leading to what may be described as multi-dimensional analysis and this is considered in Chapter 8. One outstanding omission from this chapter is an account of the work done at Harwell using digital recording on magnetic tape. The statistical nature of the events which are under observation makes it necessary to include a chapter on counting losses (Chapter 9) and oddly enough the author includes in this chapter a relatively detailed supplement to the account of barrier grid storage tubes also dealt with in Chapter 5.

As will be gathered from the above, the subject is dealt with in considerable detail, but it is the impression of the present reviewer that the presentation of the circuit details requires rather higher level of competence in the reader than might be expected from the Preface. This is the only reservation, however, to be made concerning the usefulness of an excellent text on a highly specialized subject which should be useful to a wide range of physicists, engineers and radio chemists. The make up of the book is in line with the usual excellent McGraw-Hill standard, but the price seems a little on the high side, although this is probably accounted for by the specialized nature of the subject.

J. SHARPE

Advances in Electronics and Electron Physics Vol. XIV

Edited by L. Marton. 341 pp. 146 figs. Med. 8vo. Academic Press Inc. 1961. Price 88s.

THIS volume is the second to be issued this year and contains material which could not be accommodated in the previous volume. It consists of articles by seven different authors.

Static Relays for Electronic Circuits

Edited by R. F. Rinke. 198 pp. 168 figs. Medium 8vo. Chapman and Hall Ltd. 1961. Price 63s.

THIS book is based on the recent Static Relays Symposium sponsored by the U.S. Army Signal Research and Development Laboratory. The editor defines a static relay as "an integral packaged unit marketed as a component to perform a relay-like function". Judging from the material presented in the 18 papers which are reproduced in this book, this definition includes any switching or gating device. Only two basic forms of switch described in these papers could be considered as direct replacements for the conventional relay.

The emphasis is on semiconductor circuits with the exception of two papers on Bistable Magnetic Amplifiers. These two contributions, one of which deals with basic theory and the other with circuits, contain some excellent new material, but they are rather out of place in this book. There are several new approaches to the use of diodes, tunnel diodes and transistors to signal switching and logic circuits. For power switching, the silicon controlled rectifier appears in several of the papers disguised under several different names. Two papers feature photo-sensitive devices, one of the conventional type and the other a novel photo-sensitive pnpn switch.

There are several very interesting contributions in this book, but no attempt has been made to provide any continuity between the papers. There is also a tendency for the same basic points to be

repeated again and again in the introductory paragraphs of each paper. Five of the papers contain excellent bibliography references.

The purpose of this book, as stated in the preface, is "to present a comprehensive summary of the present state of the art". This it has achieved, but many contributions are basically descriptive and there is a lack of detailed information. In view of this, the price of 63s. would seem rather high.

IAN T. BAND

Sound and Television Broadcasting General Principles

By K. R. Sturley. 382 pp. 248 figs. Demy 9. Iliffe Books Ltd. 1961. Price 45s.

THIS book explains the basic principles of sound and television broadcast engineering and operations. It is another of the BBC Engineering Training manuals and was written primarily for new recruits to the BBC Engineering Division. The introductory chapter deals with basic physical principles and their application to broadcasting. This is followed by chapters on sound and television studios, telecine and telerecording.

Dictionary of Electrical Engineering (English-Polish)

Edited by H. Zmuicki and B. Zieleniewski. 640 pp. Foolscap 4to. Panstwowe Wydawnictwa Tecgniczne. 1961.

THIS dictionary contains over 37 000 technical terms compiled from up-to-date British and American sources, with Polish equivalents or explanations. It is supplemented by the abbreviations currently used in British and American technical literature.

Introduction to the Dynamics of Automatic Regulating of Electrical Machines

By M. V. Meerov. 411 pp. 270 figs. Royal 8vo. Butterworths Scientific Publications. 1961. Price 100s.

TRANSLATED by J. S. Shapiro and published in association with D.S.I.R. Much has been written in recent years on the theory of servo-mechanisms, but very few Russian text books have been translated into English. It is thus interesting to compare a comprehensive Russian treatise on automatic regulating theory published in 1956 with that of contemporary Western authors, although the value of this text has somewhat diminished due to the delay in translation.

The main thing to note about this book is its theoretical as opposed to practical approach to control system problems. Many texts already exist which cover essentially the same ground except for a few less well known stability criteria. It is a book for the specialist in automatic control theory and possibly as a reference for engineers.

Early chapters deal with transient performances of d.c. generators, motors and synchronous generators, rotary, magnetic and electronic amplifiers, emphasis being placed on the differential equation approach to analysis. These are followed by chapters on Fourier and Laplace transforms, Routh-Hurwitz and Nyquist stability criteria with examples of stabilizing devices. The general treatment is familiar to English specialists in servo control, although the terminology is at times rather different.

Less well-known criteria include Mikhailov's which is a graphical criterion for the zeros of a polynomial (based on a similar idea to Nyquist) and also a general criterion called the 'D partition' is developed giving stability conditions when a single parameter is varied. The author proposes a method for obtaining conditions which ensure that all roots of the characteristic equation are real and negative (aperiodic stability) and goes on to obtain equations of Vyshnegradskii curves which, in a co-ordinate system of linear equation coefficients, divides the plane into stable and unstable regions. A further chapter deals with a rather tedious method for graphical solution of differential equations up to 2nd order.

Performance criteria described include a brief mention of degree of stability and a more lengthy discourse on the integral of error squared criteria.

The practical problem of the effect of neglecting small parameters receives attention but not in a manner of any great value to a practising engineer, since the method involves the derivation of the complete differential equation, from which point the complete solution is no problem when automatic computing facilities are available.

A later chapter is concerned with intermittent regulating systems taking the practical example of an alternator voltage regulator. This is followed by four chapters on non-linear theory covering different types of non-linearity, phase plane methods, point mapping of surfaces and a short chapter on the 'harmonic balance principle' which is basically the describing function technique.

As always in a treatment on servos, especially one which is formal and mathematical as opposed to practical, a high standard of mathematics is required of the reader. In general proofs are rigorous, but with the exception of the criterion of aperiodic stability for which no proof is given.

Although well over a hundred references are listed all but ten are from Russian literature.

P. N. PRIOR and R. G. WILSON

Principles of Semiconductors

By M. G. Scroggie. 156 pp. 115 figs. Demy 8vo. Iliffe Books Ltd. 1961. Price 21s.

THE whole field of semiconductors and their numerous and diverse applications are surveyed in this book, which was first published in America, but which has now been completely anglicized.

In the introductory chapters, starting from the structure of the atom, the author leads up to an explanation of the principles of semiconductors. The action of typical semiconductors and of various types of junctions are then described. A chapter on diodes and rectifiers then follows, and after a description of various types of transistors the author turns to a discussion of photocells, solar generators and photoelectro-magnetic cells. A final chapter deals with devices such as varistors, thermistors, scintillation counters, solid-state masers, strain gauges and Zener diodes.

CHAPMAN & HALL

SECOND EDITION NOW READY

High Quality Sound Reproduction

By

JAMES MOIR

M.I.E.E.

This work, for both the professional engineer and the knowledgeable amateur interested in the problem of reproducing sound with a high degree of fidelity, is now issued in a completely revised and up-to-date edition.

Illus. 75s. net

37 ESSEX STREET, LONDON, W.C.2

The Radio Amateur's Handbook

Edited by the staff of the American Radio Relay League. 724 pp. 1 300 figs. Med 8vo. The American Radio Relay League. 1961. 38th Edition. Price $4.50.

THE chapters on the theory of radio-communications have been brought up to date and material on the construction of equipment has been revised to include new designs. Theory and constructional material is also included on other important amateur radio station equipment such as test and measuring devices, and antennas.

Special methods of amateur communication, such as sideband and radioteletype, are treated in sufficient detail so that any student of the art will be able to understand the basic principles, and suitable equipments are described. The theory and practice of amateur mobile radio equipment is described, and the use of transistors is included where applicable.

ELECTRONIC EQUIPMENT

A description, compiled from information supplied by the manufacturers, of new components, accessories and test instruments.

(Voir page 825 pour la traduction en français ; Deutsche Übersetzung Seite 832)

CRYSTAL CONTROLLED CLOCK

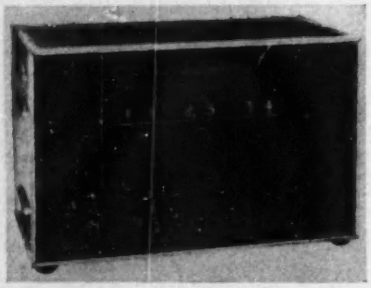
P.T.S. Electronics Ltd, 96 Horsenden Lane, Greenford, Middlesex

(Illustrated below)

This clock incorporates a 10kc/s quartz crystal with an accuracy of approximately 3 parts/10^8.

This frequency is divided down by four transistorized decades to 1sec pulses. These pulses are amplified, and fed to 6 banks of cold-cathode trigger tube ring counters, which operate 6 in line Numicators, to indicate seconds, minutes, and 12 hours, or alternatively 24 hours.

The main power supply is fully stabilized, a separate power supply being incorporated to operate the transistor circuits.



Time setting is made by switching the one second pulse to hours, and then to minutes, and then to seconds, a hold position being incorporated to stop the clock at any desired time.

An output is provided to feed a digital printer and a 50c/s pulse is available to drive standard synchronous slave clocks.

EE 40 751 *for further details*

POLYSTYRENE CAPACITORS

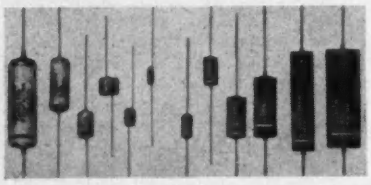
The Plessey Company Ltd, Vicarage Lane, Ilford, Essex

(Illustrated above right)

A new range of close-tolerance polystyrene capacitors is announced by the Capacitors and Resistors Division, The Plessey Company Limited. Previous limitations on the use of polystyrene as a dielectric have been largely overcome by new and improved manufacturing techniques which have improved the capacitance/volume ratio.

Standard unprotected polystyrene capacitors are normally restricted to an upper temperature limit of about 70°C because of the risk of deformation as the softening temperature is approached. Encapsulation of the capacitors reduces the risk of deformation and the rated temperature limit can be raised to 85°C.

Capacitance range in the new series is



10pF to 0·22μF. Higher values up to 0·5μF are available as non-encapsulated types and a range of aluminium cased types covering the higher capacitance values is also being marketed.

Working voltages for encapsulated and unprotected types are 125, 350, 500, 750, 1 000V. Encapsulated types are also available for operation at 2kV.

High insulation resistance and low power factor are important characteristics of polystyrene capacitors and typical values for units in the new Plessey range are 10^5MΩ and 0·005 respectively.

EE 40 752 *for further details*

DOUBLE GUN P.D.A., C.R.T.

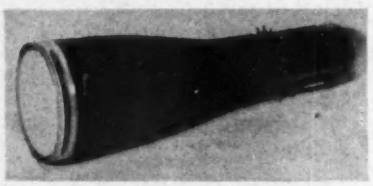
The M-O Valve Co. Ltd, Brook Green, London, W.6

(Illustrated below)

The M-O Valve Company has added a new double-gun helical p.d.a. cathode-ray tube to its range. It is a 10cm diameter tube, type 1000F, for use in general purpose oscilloscopes in which two independent signals are displayed on a common time-base.

Deflexion sensitivity in the *X* direction is 24V/cm and in the *Y* direction 14V/cm with a gun voltage of 1·2kV and a final anode potential of 4kV. The line width is approximately 0·4mm.

The two guns scan a common window of 6·3cm × 6·3cm. Side pin connexions to the deflector plates contribute to low input capacitance. The overall length, excluding base pins, is 34·8cm ±0·5cm.



EE 40 753 *for further details*

TRANSISTOR TEST METER

Grundy & Partners Ltd, 3 The Causeway, Teddington, Middlesex

(Illustrated above right)

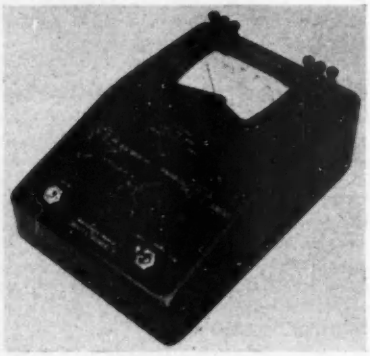
This instrument has been specifically designed to meet the requirements for a low priced universal transistor leakage test and characteristic meter.

The case is made from fibre glass and has been designed to be tough and hard wearing. The incorporated meter has a basic 100μA movement with switched ranges of 250μA, 1mA, 10mA, 100mA.

It is possible using the two sets of terminals provided to match or compare two transistors, pnp or npn, or diodes in a minimum of time under the same conditions.

Provision is made for testing the internal batteries under load, thus eliminating the possibility of error due to battery failure.

The overall size of the instrument is 11in × 7¼in × 3½in, weight 1¾ lb including batteries.



It is possible to measure collector-emitter and collector-base leakage current I_{ce0}' and I_{cb0} respectively at a potential of 4·5V.

Current gain β may be measured on transistors up to 800mW and a reasonable indication is given for higher powered transistors, the collector-emitter voltage is fixed at 4·5V.

The base input current may be varied through a pre-set range of 10, 50, 100 and 500μA, a push-button switch enables the selected base current to be increased by an increment of 1/10.

Diodes are tested in a forward direction, by passing a current of up to 10mA depending on forward resistance. The reverse current is checked at a potential of 9V.

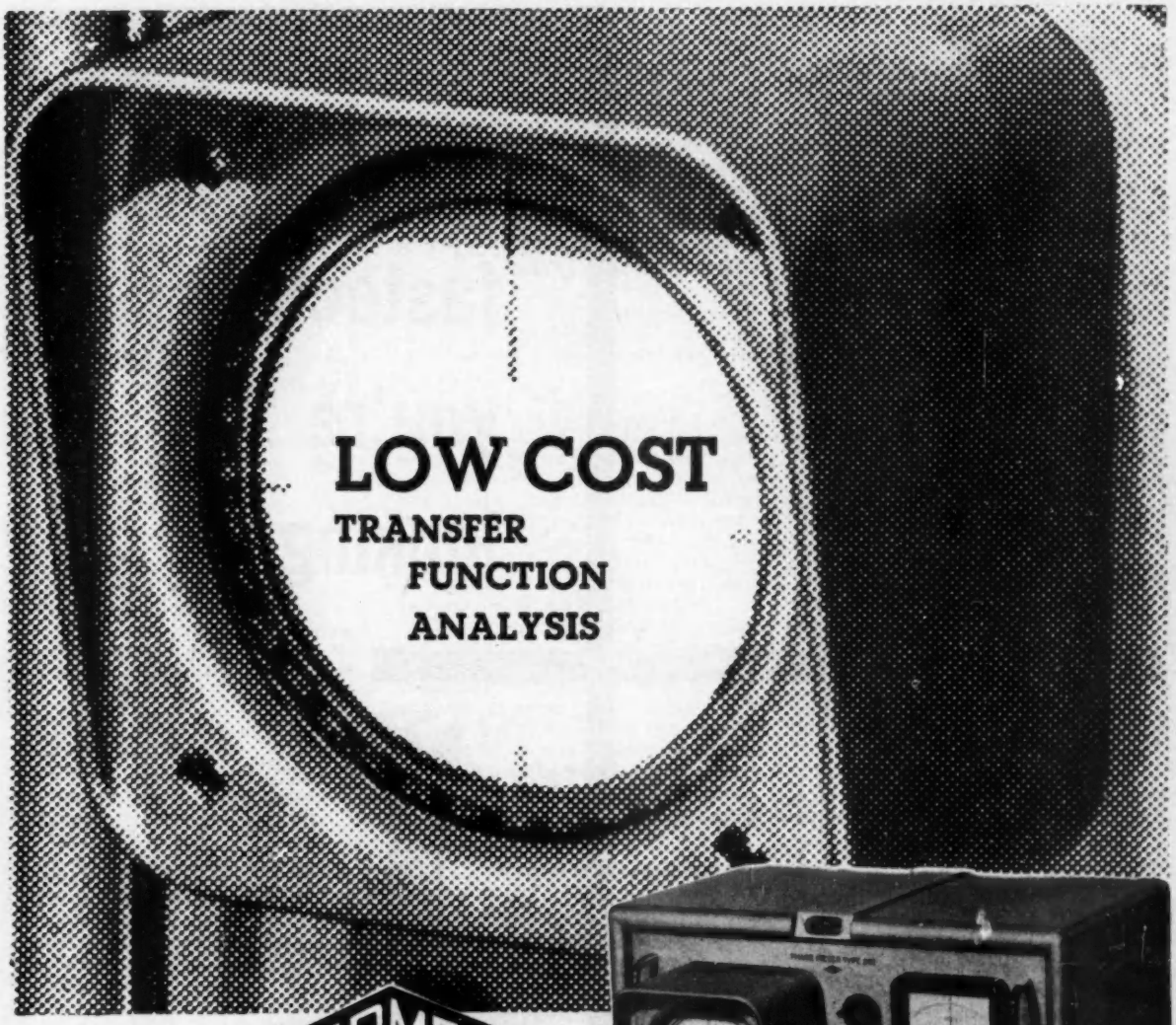
EE 40 754 *for further details*

EDGE REGISTER CONTROL

Lancashire Dynamo Electronic Products Ltd, Rugeley, Staffordshire

(Illustrated on page 819)

In many processes involving the handling of strip or web materials, it is necessary to reel the materials on to mandrels. As reeling speeds increase it becomes increasingly difficult to avoid



with the *NEW*

AIRMEC

V.L.F. PHASE METER TYPE 251

FREQUENCY RANGE: 0·01c/s to 1kc/s.

PHASE INDICATION: A reading of phase angle is obtained in one cycle by means of a brightened spot on a 6 inch C.R. tube having a circular trace and calibrated illuminated graticule.

PHASE ACCURACY: ± 2°.

AMPLITUDE MEASUREMENT: By A. C. shift technique using the built-in meter.

ACCURACY: ± 5% or ± 0·25V whichever is the greater.

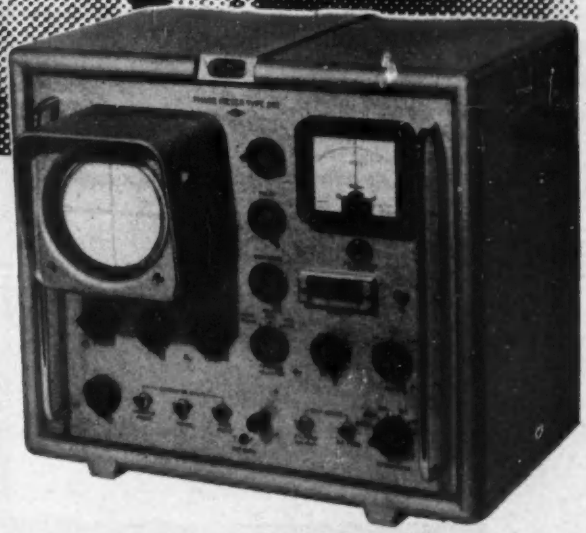
INPUT REQUIRED: In addition to the unknown input, reference in-phase and quadrature signals are required. The V.L.F. Signal Generator Type 257 provides suitable outputs over the range 0·03 to 30c/s.

INPUT LEVEL: 1—300 volts peak. Measurements on signal down to 0·1 volt peak possible with reduced accuracy.

D.C. COMPONENT: Facilities are provided for cancelling out the D.C. component which may be ± 1000 volts maximum.

An L.F. Phase Meter Type 206 is also available for phase and amplitude measurements on signals up to 100kc/s.

FOR SERVO SYSTEM, V.L.F. NETWORK AND PROCESS CONTROL SYSTEM ANALYSIS



IMMEDIATE DELIVERY—PRICE £195

Airmec

AIRMEC LIMITED

High Wycombe, Bucks. Tel.: High Wycombe 2501/7

EE 40 136 *for further details*

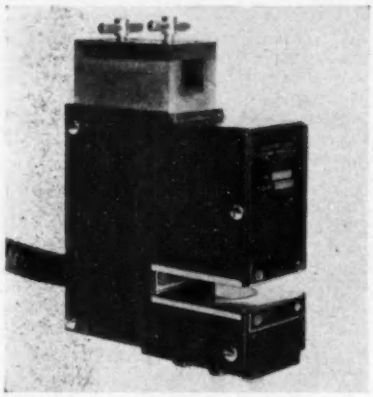
If it's fastenings you're looking for . . .

GKN. That's where the best screws come from. The best bolts and nuts, too. Fastenings of every description, from Aerotight Nuts to Z type screws. And there's no end to them either, because we are always inventing new kinds of fastenings: for all those designers and engineers without whose support we wouldn't be the largest makers of fastenings in the world.

. . get in touch with GKN

Guest Keen & Nettlefolds (Midlands) Ltd.,
Screw Division:
Box No. 24, Heath Street, Birmingham 18.
Telephone: Smethwick 1441. Telex: 33-239

t/09/1217



'wandering' of the strip or web and, therefore, to maintain a 'clean' edge on the complete reel.

The edge register control equipment (series ERC1) provides an economic means of controlling correction devices designed to position the edge of materials to within close limits. The equipment comprises a photo-electric viewing unit of 'U' shaped construction, through which the material passes, together with a remote wall-mounted control unit. Twin photocells observe the edge of the strip or web, the system being arranged so that one cell is obscured and the other illuminated when the position is correct. If the edge of the material moves, the direction of the deviation is indicated by the photocell conditions and, after an adjustable delay period, the correction arrangements are initiated. After running for a predetermined time, the correction system is brought to rest and the equipment again checks the web position, repeating this operation until the edge of the material is restored to the correct location under the viewing head.

The series ERC1 equipment includes provision for the adjustment of 'dead zone' over a 4:1 range and is accurate to within ±1/32in when set up to the optimum sensitivity. 'Correction' and 'observe' time delays are adjustable from 0·3 to 3sec and two viewing heads are available, one having a 'throat' depth of 3in and the alternative unit 6in.

EE 40 755 *for further details*

QUADRUPOLE AMPLIFIER

English Electric Valve Company Ltd, Chelmsford, Essex

The English Electric Valve Company Limited announces the introduction of a 400Mc/s quadrupole amplifier ('Adler tube') for use in applications where a very low noise figure is a necessity. The tube is packaged with a focusing solenoid and can be supplied complete with an associated power supply unit if required. With the addition of the new tube the English Electric range of quadrupole amplifiers now comprises the N1036 for operation in the 200Mc/s region, the N1037 600Mc/s tube, and the N1044.

The N1044 is a transverse field device in which an electron beam interacts with an r.f. field transverse to the normal path of the beam.

Under large input signal conditions the tube is cut-off and this affords complete protection to any following stages. Circuit paralysis or recovery time is extremely short, following the application of an excessive input signal overload.

A gain of 20dB is available with a bandwidth, to 3dB gain points, of 50Mc/s. The noise figure is less than 2dB over a bandwidth of at least 25Mc/s and the tube has a saturation output power of 50μW. The centre frequency of the N1044 is 408Mc/s and the tube operates with a magnetic focusing field of 147 gauss.

The power unit provides a d.c. stabilized supply for the solenoid, d.c. supplies for the tube electrodes and the r.f. pump power. Metering facilities are provided on the front panel to enable the tube beam current, cathode current, structure current and the electrode voltages to be measured. Controls enabling the pump level and pump frequency to be adjusted over set limits are also brought out to the front panel.

The inclusion of the power supply unit means that by making suitable mains input power supply and signal connexions the equipment may be permanently or temporarily included in new or existing designs as a low noise amplifier. Applications of quadrupole amplifiers include radar head amplifiers, input circuits for radio astronomy and tropospheric scatter communications systems, and i.f. amplifiers for millimetre equipment.

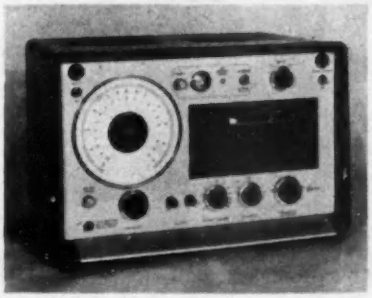
EE 40 756 *for further details*

V.L.F. FUNCTION GENERATOR

Advance Components Ltd, Roebuck Road, Hainault, Ilford, Essex

(Illustrated below)

The v.l.f. function generator type SG.88 is basically an optical-mechanical system. In this generator, the conventional oscillator circuit is replaced by interchangeable transparent rotating disks, scanned by a narrow light beam. Printed on each disk is an opaque pattern representing in polar co-ordinates the wave-shape or function to be produced. The range of wave-shape is virtually limitless, requiring only that the function from which each is derived is single-valued and repetitive. The direction of rotation of the disk can be changed to reverse the time sequence of the output waveform.

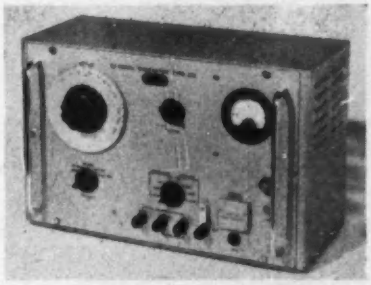


The output frequency is continuously variable from 0·005c/s up to a nominal maximum of 50c/s. By increasing the number of complete patterns on the disk, the upper frequency limit can be increased to several times the nominal value.

Acceleration of the disk on the two lower frequency ranges permits an almost instantaneous start from any predetermined point of the waveform. The periphery of the disk is calibrated in degrees for this purpose.

Sweep facilities are provided on the two upper frequency ranges to give rapid assessment of the response of the equipment under test. The frequency sweep commences at any pre-set frequency and proceeds logarithmically to the upper frequency limit of the range.

EE 40 757 *for further details*



L.F. SIGNAL GENERATOR

Airmec Ltd, High Wycombe, Buckinghamshire

(Illustrated above)

The Airmec l.f. signal generator type 252 is designed for the generation of pure and highly stable sine wave signals in the frequency range 30c/s to 300kc/s.

The oscillator consists of a Wien bridge network with thermistor feedback amplitude control, followed by a negative feedback push-pull amplifier; tuning is by means of a variable capacitor and covers the frequency band in four decade ranges with a calibration accuracy of ±1 per cent ±1c/s. Long term frequency stability is better than 0·1 per cent ±1c/s over the frequency range, and stability with supply voltage variation is 0·02 per cent (approximately) at 1kc/s for a variation of 10 per cent.

A screened and balanced output transformer provides either balanced or unbalanced outputs at an impedance of 600Ω; circuit design is such that the output impedance remains constant regardless of frequency and attenuator setting, and the output is monitored by a crystal diode voltmeter. The output can readily be made fully floating by removing an external link on the front panel, and in this condition will withstand 300V d.c. or peak a.c. to earth.

An output control provides smooth variation of output over the meter range. In conjunction with a step attenuator, it enables the output level to be set to any value from less than 1mV to 15V open-circuit with an accuracy of ±0·2dB per step, ±0·3dB overall. Output level variation over the whole frequency range of the instrument is approximately ±0·5dB,

rising to ±1dB on the 0dB attenuator setting with 600Ω resistive load.

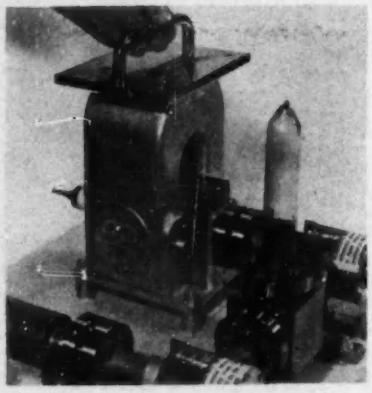
EE 40 758 *for further details*

HIGH VACUUM PUMP

Mullard Ltd, Mullard House, Torrington Place, London, W.C.1

(Illustrated below)

A new addition to the range of Mullard ultra high vacuum devices is the VPP-5 Penning pump. This pump, which is continuous in operation, is based on the principle of the Penning gauge, in which electrons are made to oscillate between cold cathodes. A magnetic field perpendicular to the direction of electron flow causes the electrons to traverse spiral paths as they oscillate in the electrostatic field formed by the



cathodes and the anode. Ions produced by these electrons are accelerated to the cathodes and liberate more electrons, the combined action being self-supporting.

The VPP-5 pump comprises many Penning electrode units in parallel using common titanium cathodes on each side of a nest of anodes. During operation, the titanium sputters from the cathode on to the anodes, forming fresh surfaces which getter very actively. The life of the pump is dependent on the amount of titanium available at the cathode for sputtering and is estimated to be 10 000 hours at a pressure of 10^{-6} torr.

The pumping action of the VPP-5 will begin at a pressure of 5×10^{-2} torr and continue until a pressure as low as 10^{-11} torr is reached. Over this range the pumping speed for air is 5 l/sec.

The VPP-5 is contained in a stainless steel case with a metal lead-in consisting of a ceramic seal. Each pump is supplied with its own magnet, which can be removed during bake-out. The pump is connected to a vacuum system by means of a flange and a demountable metal seal. The seal has a ¼in orifice and can be baked to a maximum temperature of 500°C.

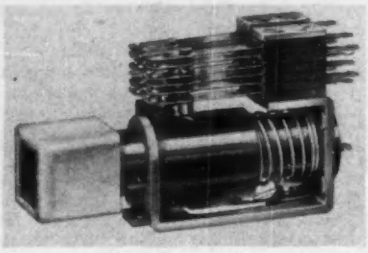
EE 40 759 *for further details*

ILLUMINATED PUSH-BUTTON KEYS

Telephone Manufacturing Co. Ltd, Martell Road, West Dulwich, London, S.E.21

(Illustrated above right)

A new illuminated push-button key for



any light current switching duty is now available from the Telephone Manufacturing Company Limited.

Available in locking, non-locking and interlocking form, the new key has applications in communications and data processing equipment as well as in test or control equipment where maximum contact loads do not exceed 100V at 300mA.

Keys can be supplied with round or rectangular push-buttons in black or white nylon, and for single, two-, ten-, or twelve-way key strips. A telephone type lamp is incorporated in the push-button body—offering considerable space-saving—and lamp illumination lenses can be in any of five colours.

Push-button bodies are made of nylon and twin silver contacts are used on all springsets—which are available as 2 or 4 changeover actions.

Overall dimensions of these new keys are 2¼in × 19/32in × 1¼in. Minimum mounting centre distance between keys is ¼in.

EE 40 760 *for further details*

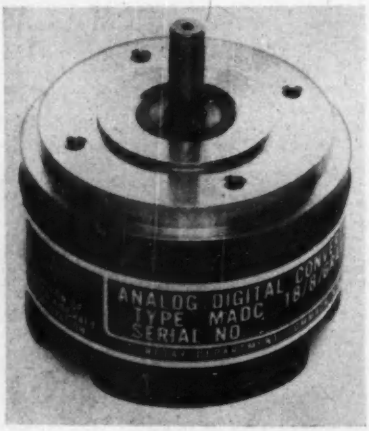
MAGNETIC ENCODER

Ketay Ltd, Eddes House, Eastern Avenue West, Romford, Essex

(Illustrated below)

A small dimension angle encoder with a Bu Ord size 18 synchro mounting developed by the United Aircraft Corporation is now available through Ketay Limited, one of the Plessey Group of Companies.

One of the simplest yet designed, this new low torque encoder provides non-ambiguous information in Gray code at 10 000rev/min. Shaft drive permits



either clockwise or anti-clockwise rotation for counting by the non-contacting magnetic unit, while output circuits are available to customers' specification.

Designed to replace brush type encoders with which it is interchangeable, the equipment has the advantages of long life and high speed in operating conditions which are unsuitable for brush types. It has been specially developed for servo and shaft position encoding for low to medium resolution, and for both single and high resolution multi-turn applications.

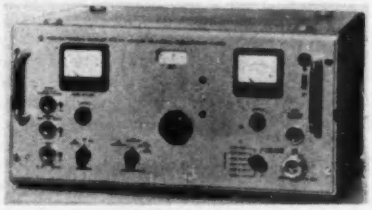
EE 40 761 *for further details*

FREQUENCY MULTIPLIER

Distributed by: Aveley Electric Ltd, Ayron Road, Aveley Industrial Estate, South Ockendon, Essex

(Illustrated below)

A times-ten frequency multiplier type XVD manufactured by Rohde & Schwarz is now available in the United Kingdom from Aveley Electric Limited.



By using this instrument, frequencies between 3 to 30Mc/s can be multiplied by ten without ambiguity since any multiplication factors other than 10 are excluded.

The amplitude of the signal is accurately indicated on a panel meter and adjusted with an attenuator. Facilities are provided for both internal and external amplitude modulation.

The frequency of the internal modulation is 1kc/s and the external modulation 30c/s to 3kc/s with a continually variable modulation depth between 0 and 90 per cent.

The instrument will also function as a free-running oscillator over the frequency range from 30 to 300Mc/s.

EE 40 762 *for further details*

TELEPHONE SCRAMBLER

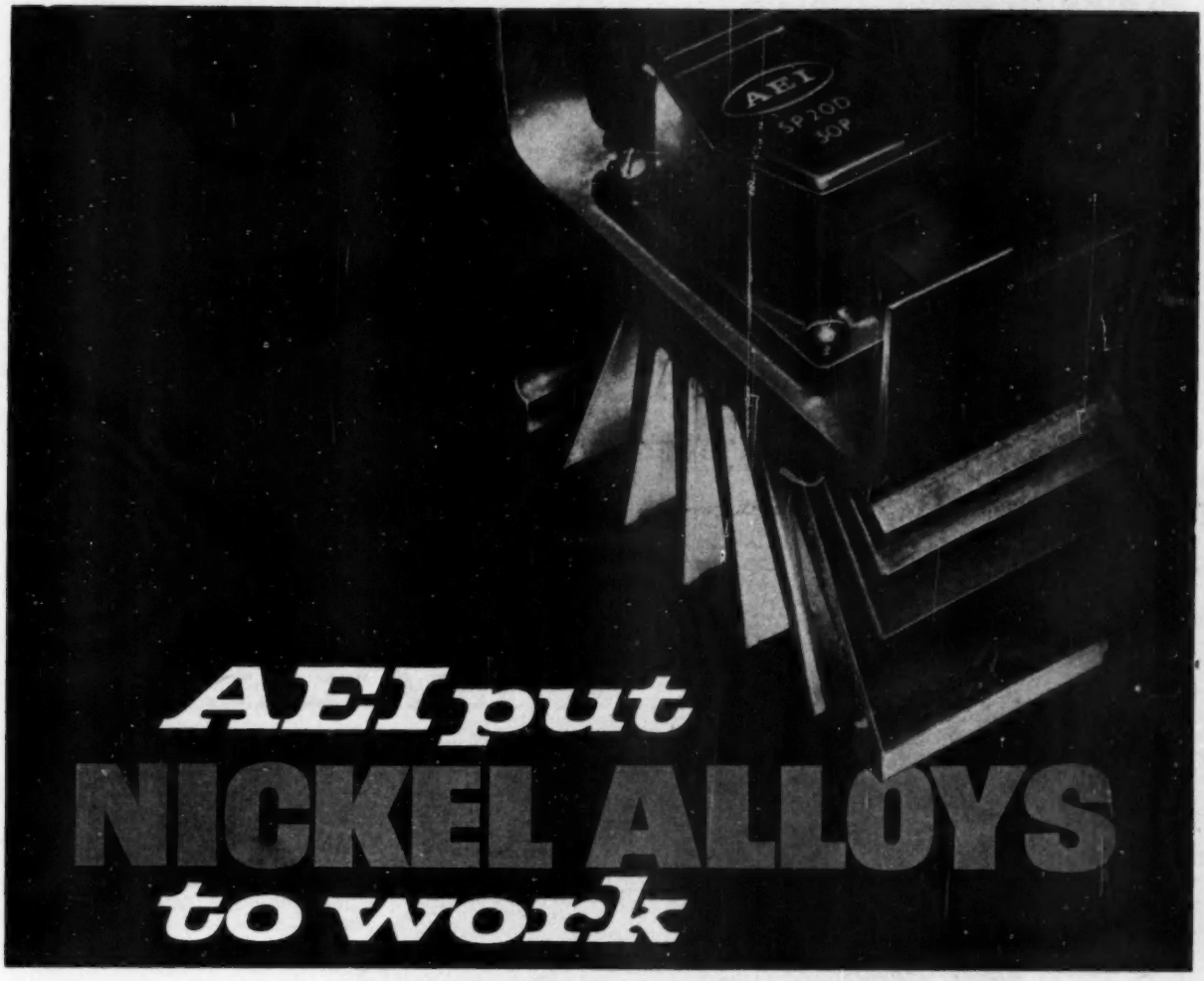
Distributed by: Westrex Co. Ltd, 152 Coles Green Road, London, N.W.2

(Illustrated on page 821)

The Westrex Company announce that they have been appointed U.K. distributors for the Delcon Security telephone, a fully transistorized electronic voice scrambler, which permits completely secure telephone conversations on any type of telephone equipment, internal and external, with no fear of eavesdropping.

The device is a battery operated instrument which is held against the normal telephone handset, without the need for wiring or permanent fittings of any kind. It scrambles the conversation so that it cannot be understood by anyone except the person holding an identical instrument at the other end of the

EE 40 137 *for further details*



AEI put NICKEL ALLOYS to work

In semiconductor power rectifier cells

In order to meet the precise material specifications required in the production of semiconductor rectifiers, AEI (Rugby) have selected several Wiggin high-nickel alloys to overcome problems of purity, corrosion and expansion.

Design engineers and others interested in obtaining fuller information on this interesting application of our alloys, are invited to send for a copy of our journal '*Wiggin Nickel Alloys*' *No 61*.

*TRADE MARK

Semiconductor power rectifier cells on cooling fins. *Above* silicon, *below* germanium. The body of the cell above is in *Monel** alloy, chosen because it meets the need for absolute cleanliness during assembly and operation, ease in welding, and resistance to corrosion.

To Henry Wiggin & Co Ltd, Holmer Road, Hereford
Please send me without charge a copy of *Wiggin Nickel Alloys No 61*

NAME _____

APPOINTMENT OR DEPARTMENT _____

COMPANY AND ADDRESS _____

EL/E13/12

HENRY WIGGIN & COMPANY LTD HOLMER ROAD HEREFORD

TGA 212

EE 40 138 *for further details*

KONAXAL

An outstanding NEW fitting for co-axial cables

Now in use in this country for relayed television—Kay's new range of gunmetal junctions and connections for co-axial cable . . .

*** 85% copper content gives a conductivity unobtainable with brass, aluminium or steel.**

*** Two-, three- or four-way junction boxes operate with ends suitable for any combination of sizes for co-axial cable.**

*** A perfect electrical joint is made by the copper cone with any type of co-axial cable.**

*** Fittings and boxes are water and weather-proof: gunmetal provides corrosion resistance.**

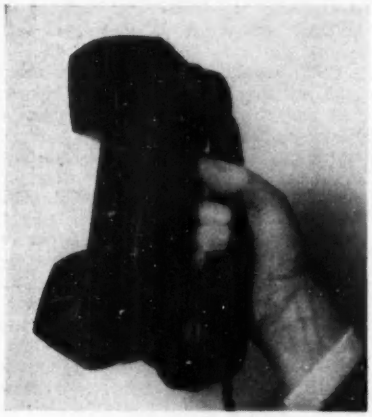
*** Two to three week delivery on all orders.**

*** Special fittings to order.**

KONAXAL

KAY & CO (ENGINEERS) LTD · BOLTON · LANCS · TEL: BOLTON 21041/4

A member of the Alenco Group of Companies



line. It is lightweight and portable (24oz) and fits easily into a briefcase or handbag for use when away from the office.

The equipment is supplied in matched sets, coded to ensure that each customer has his own private set which cannot be understood by any other purchaser of similar equipment.

The equipment is available in three types—push-button operation, fully automatic operation, and for mobile f.m. radio telephone equipment.

EE 40 763 *for further details*

VARIABLE PHASE STANDARD

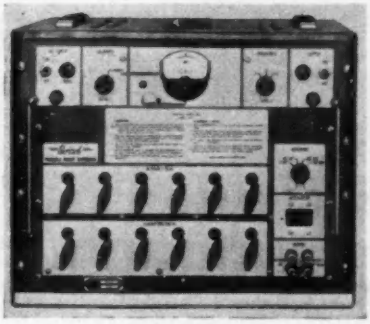
Wayne Kerr Laboratories Ltd, 44 Coombe Road, New Malden, Surrey

(Illustrated below)

A variable phase standard which allows the phase between two self-generated voltages to be shifted to any desired angle with a minimum accuracy of ±0·05° is now available from the Wayne Kerr Laboratories Limited.

Operating over three adjustable frequency ranges between 150c/s and 3kc/s, this new instrument (designated VPS-1) generates two voltages of equal amplitude differing in phase by any angle from 0° to 360°. The reference voltage has a fixed amplitude of 50V r.m.s. while the vector output, which may be displaced in phase in increments of one minute of arc, has a maximum amplitude of 50V r.m.s. and can be attenuated in 50mV steps.

An interesting feature incorporated in the VPS-1 is the approach to the precise generation of voltage vectors, the voltage of known phase with respect to the reference voltage being arrived at by obtaining the in-phase and quadrature components and then summing these vectors.



The instrument is entirely self-contained, requiring no external equipment for calibration or operation, and is available in a case or ready for rack mounting.

EE 40 764 *for further details*

PHASE METER

Dawe Instruments Ltd, Western Avenue, Acton, London, W.3

(Illustrated below)

The type 630 phase meter is a fully transistorized instrument for the measurement of the difference in phase between two electrical signals in the audio and sub-audio frequency range.

Both the signal and reference channel are fed to current attenuators, whose output in turn feeds balancing circuits followed by amplifying and shaping circuits which drive bistable circuits whose outputs are differentiated to derive positive-going pulses with the same phase

relationship as that of the positive-going excursions of the input signals. Pulses from one channel switch a further bistable circuit 'on,' while those from the other switch it 'off.' The resulting rectangular waveform signal has a mark-to-space ratio directly proportional to the phase difference of the input signals. It is integrated and applied to a moving-coil meter, whose scale is directly calibrated in angular degrees from 0° to 360°. For ease of reading when the signals are almost in phase, a 180° phase-shift circuit may be selected and the results read against a 180°-0°-180° scale.

The instrument has a frequency range from 1c/s to 25kc/s. The attenuators provide either low voltage sensitivity at high input impedance or vice versa, the value ranging from 30 to 300V r.m.s. into 10MΩ to 0·03 to 0·3V r.m.s. into 10kΩ. With balanced signals and using the 0 to 360° scale, accuracy is better than ±3° above 10c/s.

Eight type U11 batteries render the unit fully self-contained and suffice for about 40 hours' operation. A power unit for operation from 100 to 125V and 200 to 250V mains supplies is also built in.

EE 40 765 *for further details*

D.C. AMPLIFIER

Fenlow Electronics Ltd, Springfield Lane, Weybridge, Surrey

A simple transistorized d.c. amplifier has been developed to give a low drift without resorting to chopper correction techniques, and to give a larger output voltage swing than is usual on transistor equipment. The Fenlow amplifier type A.101, designed to work up to 55°C has an input impedance of 13kΩ and the gain can be adjusted between four and several hundred by simply changing an external feedback resistor; the bandwidth at a gain of 20 is approximately 1kc/s. The output will provide a voltage swing of +30 to −30V into a load of 20kΩ, or a slightly smaller swing into a load down to 5kΩ. A typical drift figure referred to the input, when the amplifier is used under indoor conditions, is 5mV/h. A control for setting zero is provided.

EE 40 766 *for further details*

TRANSISTOR POWER SUPPLIES

J. Langham Thompson Ltd, 176 High Road, Bushey Heath, Hertfordshire

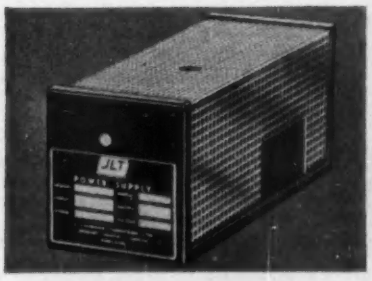
(Illustrated below)

J. Langham Thompson Ltd have extended their range of low voltage transistor power supplies.

Primarily intended for 'built in' applications attention has been paid to mounting arrangements and physical dimensions. The three new ranges with ratings of 20VA, 30VA and 60VA can be mounted in groups of 5, 4 and 3 respectively behind standard 19in panels. A perforated metal case gives adequate protection where bench operation is desired.

All units are fully protected against short-circuit and overload by patented electronic circuits and in the case of the 30VA units re-setting is automatically effected when the overload is removed.

Fixed voltages between 5 and 60V can be provided at currents determined by the maximum VA ratings of the three basic ranges and a 1½A unit permits continuous voltage variation between 4 and 12·5V. Double regulator techniques are used in the 30VA and 60VA units to give exceptionally good regulation and improved efficiency. In the case of the 20VA units the emphasis has been on small size and here a well regulated output is provided by a unit measuring only 3¼in × 3¼in × 8in.



The double regulator techniques used permit large input voltage swings while still maintaining constant output voltages.

The output, which is completely free from transients, contains only 1mV r.m.s. of ripple and the source impedance is as low as 0·01Ω for most models.

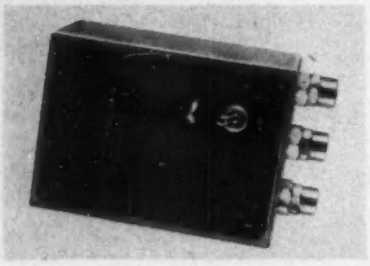
EE 40 767 *for further details*

ROTATION MONITORS

Pentechnique Ltd, Imperial Lane, Cheltenham, Gloucester

(Illustrated below)

These units have been designed to give a warning when a monitored shaft (or any reciprocating or linear motion) slows down or stops. Pulses obtained from the shaft by means of any of the various types of Pentechnique magnetic transducers hold a relay in the shaft rotation monitor in an energized condition. When the shaft stops rotating the



relay becomes de-energized and the relay contacts actuate alarm signals, warning lights or other control signals. Semiconductor devices are used throughout and a power supply is incorporated enabling the equipment to be operated from normal mains supplies.

Although normally intended for use with magnetic pick-ups, versions are available for use with switch contacts and photo-electric pick-ups.

Special versions can be supplied to switch at specified shaft speeds and other modifications include the provision of alternative relays, power transistor output stages (for the direct operation of small solenoids), variable delayed pull-in and drop-out circuits, and power supplies for different mains voltages.

EE 40 768 *for further details*

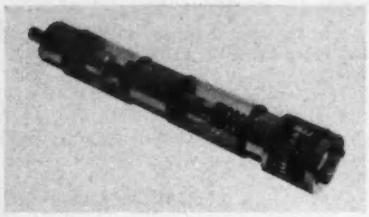
VACUUM SWITCH

Ferranti Ltd, Hollinwood, Lancashire

(Illustrated above right)

A new vacuum switch designed primarily for high voltage pulse forming network switching in radar modulators is announced by Ferranti Limited. This switch has been developed to meet a requirement for a component which would enable pulse lengths in airborne radar equipment to be changed easily.

The type 13VSBI switch comprises a glass and metal vacuum envelope containing two contacts—one fixed and the other moveable—both of which are insulated from the earthy end to withstand a maximum pulse voltage of 15kV.



The moving contact is actuated by means of a solenoid against a spring load, which holds the contacts closed. The switch is normally closed and the contacts only move about 0·020in.

Ratings for this 'on-off' switch are: maximum pulse voltage 15kV; maximum pulse current 100A; d.c. test voltage 30kV; operating time 5msec maximum; contact resistance (closed position) 0·02Ω maximum; capacitance between contacts (open position) 1·5pF maximum. Solenoid ratings are: 24V d.c. supply; coil resistance 20Ω ±10 per cent; pull-in current 1A maximum; hold-in current 100mA maximum. These ratings apply in ambient pressures down to 560mm Hg, and the switch is capable of withstanding the normal shock, vibration and centrifugal tests associated with unpressurized airborne electronic equipment. The switch is designed to operate in the absence of current or voltage. The vacuum dielectric ensures that accidental switching up to the full ratings will not result in permanent damage.

The switch is 6in long overall, with a diameter of 1in and weighs 6oz.

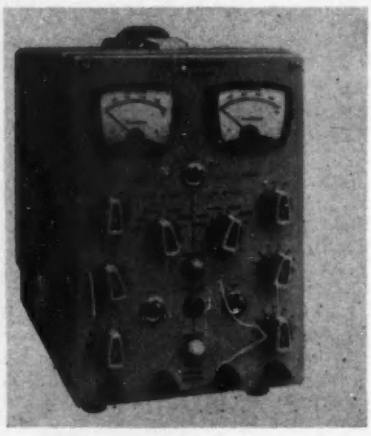
EE 40 769 *for further details*

TWIN POWER SUPPLY

Solartron Laboratory Instruments Ltd, Cox Lane, Chessington, Surrey

(Illustrated below)

Solartron's latest power unit type AS 1164, comprises twin 0 to 30V 'floating' supplies each of 1A capacity. Outputs are independently adjustable in 0·1V increments by decade switching. They can be used separately as positive and negative supplies, switched into parallel operation to give 2A capacity, linked in series to provide a tapped 0 to 60V supply or connected back-to-back to

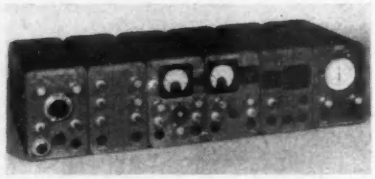


give ±30V—0—±30V. The accuracy of voltage adjustment is ±2 per cent ±2mV.

Each supply has separate overload limit selectors (25, 50, 100, 250, 500mA, 1A) and current monitoring meters. A fully electronic proportional control system provides a method of protecting, not only the power unit, but also the circuit it supplies. Overload warning indicators are provided for each supply. In parallel operation there is one set of over-riding output level controls, but the current limit selectors remain operative and independent. This doubles the overload limit to 2A with finer intermediate settings.

The stability factor of each output is greater than 1 000:1, ripple and noise 1mV peak-to-peak and regulation approximately 0·1 per cent at maximum output. Output impedance is less than 0·35Ω up to 100kc/s.

EE 40 770 *for further details*



TRANSISTORIZED NUCLEONIC INSTRUMENTS

Nuclear Enterprises (G.B.) Ltd, Bankhead Medway, Sighthill, Edinburgh 11

(Illustrated above)

Nuclear Enterprises (G.B) Limited has produced a series of transistorized and printed circuit nucleonic instruments in conjunction with A.W.R.E., Aldermaston.

The series is composed of a number of functional units built in standard blocks of uniform dimensions, and the individual units may be combined in a variety of ways for different experimental investigations. Four units can be fitted side by side on a shelf in a standard 19in rack. The unit dimensions are 4in wide by 6in high by 10in deep. All connexions for power and signals are made through the front panel. Plug-in printed circuit boards are used to facilitate servicing.

Amplifier (NE 5252)

The amplifier has an overall voltage amplification of 1000 times with a preamplifier stage for high input impedance and three amplifier stages each with ten times amplification. The unit features good linearity and low noise. Power is obtained from a companion unit (NE 5352).

Analyser (NE 5152)

The analyser is capable of accepting random pulses at a rate of approximately 30kp/s. The channel width can be varied in 0·2V steps from 0·2V to 1·0V and the total range of the pulse amplitude level control is 10V. The amplitude level may be swept (a) manually, (b) by a sweep recorder using an external bias control

PERIPHERAL DATA EQUIPMENT BY WESTREX

Both the Westrex High Speed Punch and the Westrex High Speed Reader are fast, accurate and dependable units. Used in conjunction they provide the complete answer to peripheral equipment in data processing systems equally suited to companies investing in this type of installation for the first time and to those making replacements and additions.

With experience and service in the U.K and the U.S.A to call on, Westrex can give you at once, or quickly find out, the best answers to your data processing problems.

If you would like advice, or further information on the equipment shown here, please write or telephone.

THE PUNCH

Code Levels: The BRPE 110 (ch.p.s) sets are available for perforating 5-level code in $\frac{11}{16}$-inch tape; or 8-level code in 1-inch tape. The latter may be readily readjusted for perforating 7-level or 6-level codes in $\frac{3}{4}$-inch tape.

Magnetic Synchronising Mechanism: A new magnetic synchroniser triggers the external signal storage, and has a simplified range adjuster to insure signal transfer at optimum point of operating cycle.

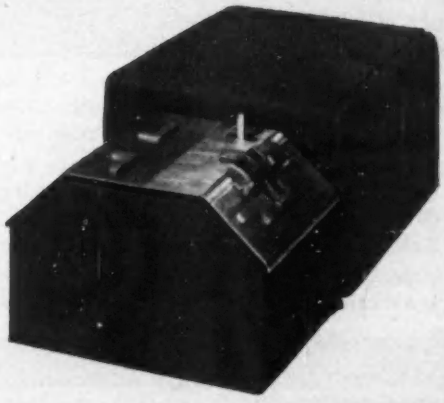
Code Magnets: Code magnets, which control the code perforating punch-pin mechanism and the feed-tape mechanism, are adjusted individually.

'Low Tape' Warning Mechanism: The tape reel on the BRPE 110 is equipped with a 'low tape' warning mechanism which can be connected to external alarms.

Optional extras: 'Broken tape' warning switch totally enclosed soundproof cover; additional synchronising pick up coil; code magnet impedance to specification.

THE READER

Clean and simple design makes for low cost and minimum maintenance. Wide range of operating speeds. Magnetic synchronising device. Reliable operation at 110 characters per second.

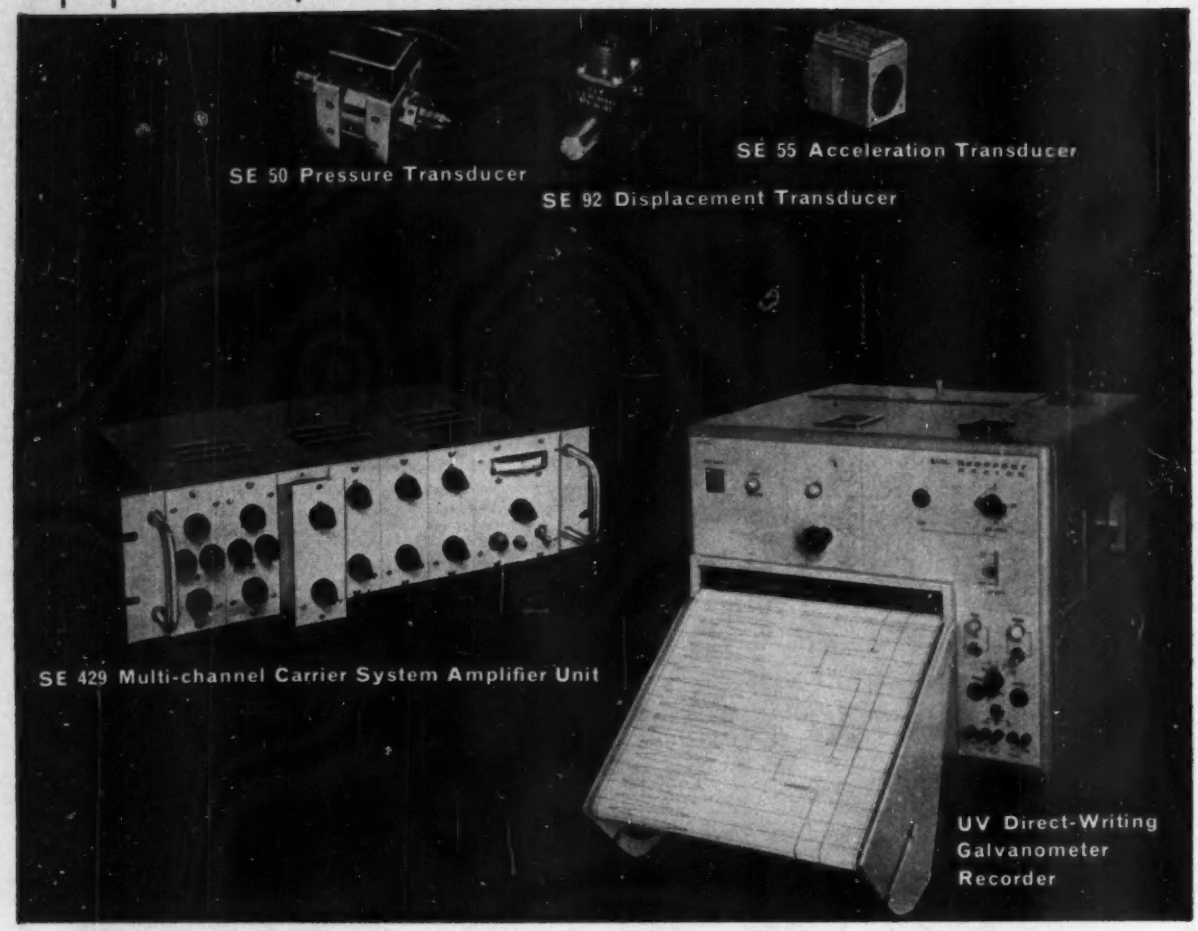


Westrex

WESTREX COMPANY LIMITED · COLES GREEN ROAD · LONDON · NW2 · TELEPHONE: GLADSTONE 5401

TDW 15

S|E|L complete data recording systems


SE 50 Pressure Transducer
SE 92 Displacement Transducer
SE 55 Acceleration Transducer
SE 429 Multi-channel Carrier System Amplifier Unit
UV Direct-Writing Galvanometer Recorder

SE Laboratories offers complete, integrated systems of data handling instrumentation, including transducers, carrier systems, direct-writing UV recorders, and data loggers up to 1,000 channels. All this SEL equipment is based on well-tried circuits and principles, and provides the most advanced range of operating features: ● *Sensitive pressure and displacement transducers, accelerometers* ● *Fully transistorised carrier systems with printed circuits* ● *Two- or four-arm inductive and resistive bridges, DC—500 c/s* ● *Compact, rack-mounted oscillator, demodulator, carrier amplifier units* ● *Direct-writing UV Galvanometer Recorder up to 50 channels, 12" paper* ● *Reliable, robust and small size throughout* ● *A flexible system, to amplify and present simultaneous information from inductive and resistive transducers to indicators, recorders, oscilloscopes and data logging instruments*

For full details of these and other SE Laboratories products — control and venting valves, flowmeters, etc, contact:

SE LABORATORIES | ENGINEERING | LTD

North Feltham Trading Estate, Feltham Middlesex. Telephone: Feltham 5876

(as with the modified Honeywell-Brown recorder) or (c) by an internal sweep circuit, permitting display on a memory oscilloscope.

Power Unit (*NE 5352*)

The power unit supplies both the l.t. for several units and the e.h.t. for photomultipliers, Geiger-Mueller tubes or proportional counters. The e.h.t. is continuously variable from 500V to 3kV.

Rate-meter (*NE 5452*)

The rate-meter unit has a maximum counting rate of 30kp/s in eight ranges. Below 10 counts per second pulses are counted on an electromechanical register. The counting rate is indicated on a meter.

Sealer (*NE 5072*)

The scaler has a resolving-time of 1μsec and can store 10^9 counts. The display is by neon bulbs up to 10^6 and the remaining four digits on an electromechanical register. Remote control of counting time is possible as is also resetting, except for the register.

Timer (*NE 5052*)

The time pulses are produced at half-second intervals by a stop-watch and elapsed times from 5sec to 20 000sec may be selected.

EE 40 771 *for further details*

VACUO-JUNCTION TUBES

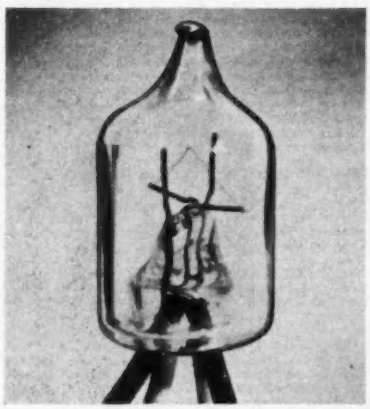
Best Electrics Ltd, Ranelagh House, Felixstowe, Suffolk

(*Illustrated below*)

Best Electrics Limited vacuo-junction tubes are specialized thermal convertors which may be used as a.c. to d.c. transfer standards over a very wide range of frequencies. They are, in fact, vacuum enclosed bi-metal devices.

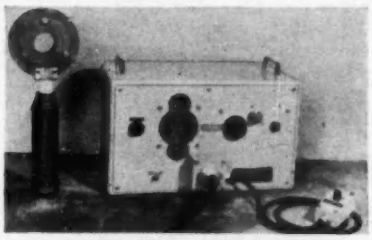
In the vacuo-junction tube, the junction is placed in thermal contact with a heating filament, which carries the current to be measured. The structure is contained in an evacuated glass envelope to minimize heat losses. Since the thermal e.m.f. developed is proportional to the junction temperature, it will now also be proportional, in turn, to the square of the heater current.

By measuring the thermal e.m.f. on a suitable calibrated millivoltmeter, an indication is given of the applied current. If the instrument is calibrated on d.c., then the same calibrations will hold, within very close limits, on a.c. Further, since the vacuo-junction measures the heating effect of the applied current, indicated readings will be true r.m.s. values, regardless of waveform. Within the frequency range 25c/s to 20kc/s, the vacuo-junction is accurate to within 0·01 per cent for all measurements.



Three patterns of Best vacuo-junctions permit between them accurate measurements to be made over a frequency range extending from below 0·1c/s to several hundred megacycles. Each pattern is available with a variety of heater ratings, the most sensitive being rated at 1mA maximum heater current.

EE 40 772 *for further details*



PIN HOLE DETECTOR

Witton Electronics Ltd, Bickford Road, Witton, Birmingham 6

(*Illustrated above*)

This electronic pin hole detector is suitable for inspecting the insulating coating of metal pipes, either during manufacture or in the field.

The equipment comprises an electronic unit, suitable for operation from mains supply or 12V battery, and a scanning head.

When the scanning head is moved by the operator along the pipe any fault or pin hole in the insulated coating is located by a non-lethal high voltage discharge, which gives an audible and illuminated signal on the control unit.

The scanning head can be supplied with interchangeable or split rings to suit various sizes of pipe.

EE 40 773 *for further details*

DIGITAL VOLTMETER-COUNTER

Southern Instruments Ltd, Frimley Road, Camberley, Surrey

(*Illustrated above right*)

The digital voltmeter-counter type M.1155 will measure voltage from 1mV to 500V and frequency from 0·1c/s to 120kc/s using a count period of 0·1, 1 or 10sec. It will also measure time intervals, defined by electrical signals or contact closures, of 1msec to 27·7h. In addition, it provides crystal controlled clock pulses of 0·1, 1 and 10msec and 0·1, 1 and 10sec. On all functions the input impedance is of a high order.

A bright display with a wide viewing angle is achieved with projection type in-line indicators. A latching system, which is released momentarily at the end of each count, provides a continuous display that is uninterrupted by the counting period.

The instrument is mains powered, and is compact, portable and robust, making it equally suitable for laboratory and industrial applications.

EE 40 774 *for further details*

SELECTIVE GAMMA MONITOR

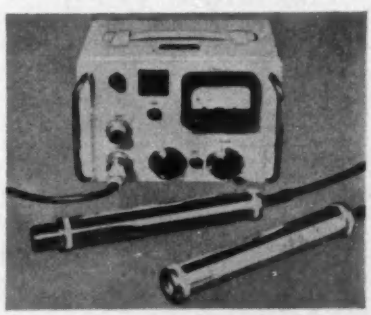
Plessey Nucleonics Ltd, Weedon Road, Northampton

(*Illustrated below*)

Plessey Nucleonics Limited has introduced a compact selective gamma monitor, type PNI 1118, capable of detecting small quantities of those radio-active materials emitting gamma rays in the energy range 10keV to 1·5MeV. The monitor detects these rays by means of a scintillation counter followed by a single channel pulse amplitude analyser. All circuits employ transistors. The monitor is mains or vehicle battery operated, is readily transportable, and is provided with 6ft of connecting cable between the indicator unit and detector probe.

The detector probes available cover the ranges 10 to 60keV, 50 to 300keV and 250keV to 1·5MeV respectively, and consist of thallium activated sodium iodide scintillators mounted on the end of photomultiplier tubes. Adjustment of e.h.t. is provided on the individual probes, and the connexion of any one probe automatically sets the required e.h.t. The supply is variable from 500 to 1500V.

Threshold bias is preset for the single channel pulse amplitude analyser, and channel width is switched to give 50, 25 and 10 per cent channels on the 10 to 60keV, 50 to 300keV and 0·25 to 1·5MeV ranges respectively. Channel widths are preset internally.



EE 40 775 *for further details*

Meetings this Month

THE BRITISH INSTITUTION OF RADIO ENGINEERS

Unless otherwise stated, all meetings will be held at the London School of Hygiene, Keppel Street, Gower Street, W.C.1.

Computer and Medical Electronics Group
Date: 6 December. Time: 6 p.m.
Lecture: Possible Uses of Computers in Medical Diagnosis.
By: A. D. Booth.

Television Group
Date: 13 December. Time: 6 p.m.
Lecture: Discussion on Colour Television.

South Midlands Section
Date: 1 December. Time: 7 p.m.
Held at: North Gloucestershire Technical College, Cheltenham.
Lecture: Electronic Telephone Exchanges.
By: J. F. Hesketh.

South Wales Section
Date: 6 December. Time: 6.30 p.m.
Held at: College of Advanced Technology, Cardiff.
Lecture: Microwave Valves.
By: R. W. White.

South Western Section
Date: 20 December. Time: 6 p.m.
Held at: School of Management Studies, Bristol. Annual General Meeting.
Lecture: V.H.F. Communications Receivers and Transmitters Using Transistors.
By: A. J. Rees.

West Midlands Section
Date: 6 December. Time: 7.15 p.m.
Held at: Wolverhampton College of Technology.
Lecture: New Electronic Techniques in Non-Destructive Testing.
Date: 21 December. Time: 6.15 p.m.
Held at: Birmingham University.
Lecture: The R.R.E. Radio Telescope Interferometer.
By: H. Gent.

North Western Section
Date: 7 December. Time: 7 p.m.
Held at: Reynolds Hall, Manchester College of Science and Technology.
Lecture: Radar for Civil Aviation Purposes.
By: K. F. Slater.

Scottish Section
Date: 13 December. Time: 7 p.m.
Held at: Institution of Engineers and Shipbuilders, 39 Elmbank Crescent, Glasgow.
Lecture: Jodrell Bank.
By: J. B. Wilson.

Merseyside Section
Date: 13 December. Time: 7.30 p.m.
Held at: The Walker Art Gallery, Liverpool.
Lecture: Nuclear Power Station Instrumentation.
By: M. W. Jarvis.

North Eastern Section
Date: 13 December. Time: 6 p.m.
Held at: Institution of Mining and Mechanical Engineers, Neville Hall, Westgate Road, Newcastle upon Tyne.
Lecture: Masers and Parametric Amplifiers.
By: T. H. Wilmhurst.

East Midlands Section
Date: 6 December. Time: 6.45 p.m.
Held at: University of Leicester, University Road.
Lecture: Transistors in Computers and Control Equipment.
By: P. James.

THE INSTITUTE OF PHYSICS AND THE PHYSICAL SOCIETY

All meetings will be held at Headquarters, 47 Belgrave Square, London, S.W.1.

Date: 8 December. Time: 2.30 p.m.
Lecture: Electron Microscopy in Japan.
By: T. Mulvey and Dr. M. Whelan.
Date: 12 December. Time: 2.30 p.m.
Half-Day Meeting on Strain Gauges.
Date: 12 December. Time: 5.30 p.m.
Lecture: Integrated Electronics.
By: Dr. J. W. Granville.

THE INSTITUTION OF ELECTRICAL ENGINEERS

All meetings will be held at Savoy Place, London, W.C.2, commencing at 5.30 p.m., unless otherwise stated.

Education Discussion Circle
Date: 6 December.
Lecture: Teaching Protective Systems.
By: G. Heywood.

Measurement and Control Section
Date: 5 December.
Lecture: Domains and Domain Pattern.
By: L. F. Bates.
Date: 19 December.
Lecture: The Use of Controllable Semiconductor Rectifiers in Machine Control.
By: K. G. King.

Ordinary Meeting
Date: 7 December.
Lecture: Magnetohydrodynamics.
By: M. W. Tring.

Medical Electronic Discussion Group
Date: 8 December.
Lecture: The Peltier Hall and Seeback Effects.

Electronics and Communications Section
Date: 4 December.
Lecture: Backward Waves in Waveguides.
By J. B. Clarricoats, R. A. W. Waldron and G. H. B. Thompson.
Date: 12 December.
Lecture: Diversity Reception and Automatic Phase Reception.
By: L. Lewin.
Date: 18 December.
Lecture: Large Microwave Steerable Aerials for Communication with Artificial Earth Satellites and Space Probes.
By: F. J. D. Taylor.
Date: 20 December.
Lecture: Satellite Instrumentation.
By: R. L. F. Boyd.

Supply Section
Date: 13 December.
Lecture: Electrical Aspects of Hunterston Nuclear Generating Station.
By: J. Henderson, G. F. Kennedy and J. Wootton.

Utilization Section
Date: 14 December.
Lecture: Oscillating Machines—Synchronous and Asynchronous.
By: E. R. Laithwaite.
Lecture: An Oscillating Synchronous Linear Machine.
By: R. S. Mamak.

THE INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS

Date: 11 December. Time: 5 p.m.
Held at: The Institution of Electrical Engineers, Savoy Place, London, W.C.2.
Lecture: The Dollis Hill Model Electronic Exchange.
By: J. F. Hesketh.

THE RADAR AND ELECTRONICS ASSOCIATION

Date: 14 December. Time: 7 p.m.
Held at: Royal Society of Arts, John Adam Street, Adelphi, London, W.1.
Lecture: Loudspeaker Enclosures.
By: J. Gough and F. Landgrebe.

THE SOCIETY OF INSTRUMENT TECHNOLOGY

London Meetings
Control Section
Date: 13 December. Time: 7 p.m.
Held at: Manson House, 26 Portland Place, London, W.1.
Lecture: Application of Complex Plane Methods to System Design.
By: P. K. M'Pherson.

Bristol Section
Date: 14 December. Time: 7.30 p.m.
Held at: Department of Physics, University of Bristol, The Royal Fort, Bristol 8.
Lecture: The Atomic Clock.
By: L. Essen.

Chester Section
Date: 12 December. Time: 7 p.m.
Held at: Stanley Palace, Watergate Street, Chester.
Lecture: Design Application and Selection of Automatic Control Valves.
By: P. Stone.

Fawley Section
Date: 1 December. Time: 5.45 p.m.
Held at: Room 4a, Administration Building, Esso Petroleum Company Limited, Fawley.
Lecture: Applications of Transistor and Diodes.
By: D. Osborne.

Grangemouth Section
Date: 21 December. Time: 7 p.m.
Held at: Leapark Hotel, Bo'ness Road, Grangemouth.
Lecture: Instrumentation of Space Vehicles.
By: Dr. A. E. Roy.

Liverpool Section
Date: 14 December. Time: 7 p.m.
Held at: Merseyside and North Wales Electricity Board, Industrial Centre, Paradise Street, Liverpool.
Lecture: The Versatility of Electronic Potentiometer.
By: F. W. J. Howard.

THE TELEVISION SOCIETY

Date: 8 December. Time: 7 p.m.
Held at: Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, London, W.C.2.
Lecture: Remote Control Operation of Television Cameras.
By: H. C. Nickels.
Date: 15 December. Time: 7 p.m.
Held at: Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, London, W.C.2.
Lecture: The "New Eye" Vidicon Camera.
By: N. S. Rutherford.

PUBLICATIONS RECEIVED

LEAD CABLE SHEATHING is the second publication in the series issued by the Lead Development Association. This booklet describes the requirements for cable construction and conditions of installation and explains how they may be met by selection from the lead sheathing alloys commonly available in the U.K. Copies of this publication are available from the Association at 34 Berkeley Square, London, W.1.

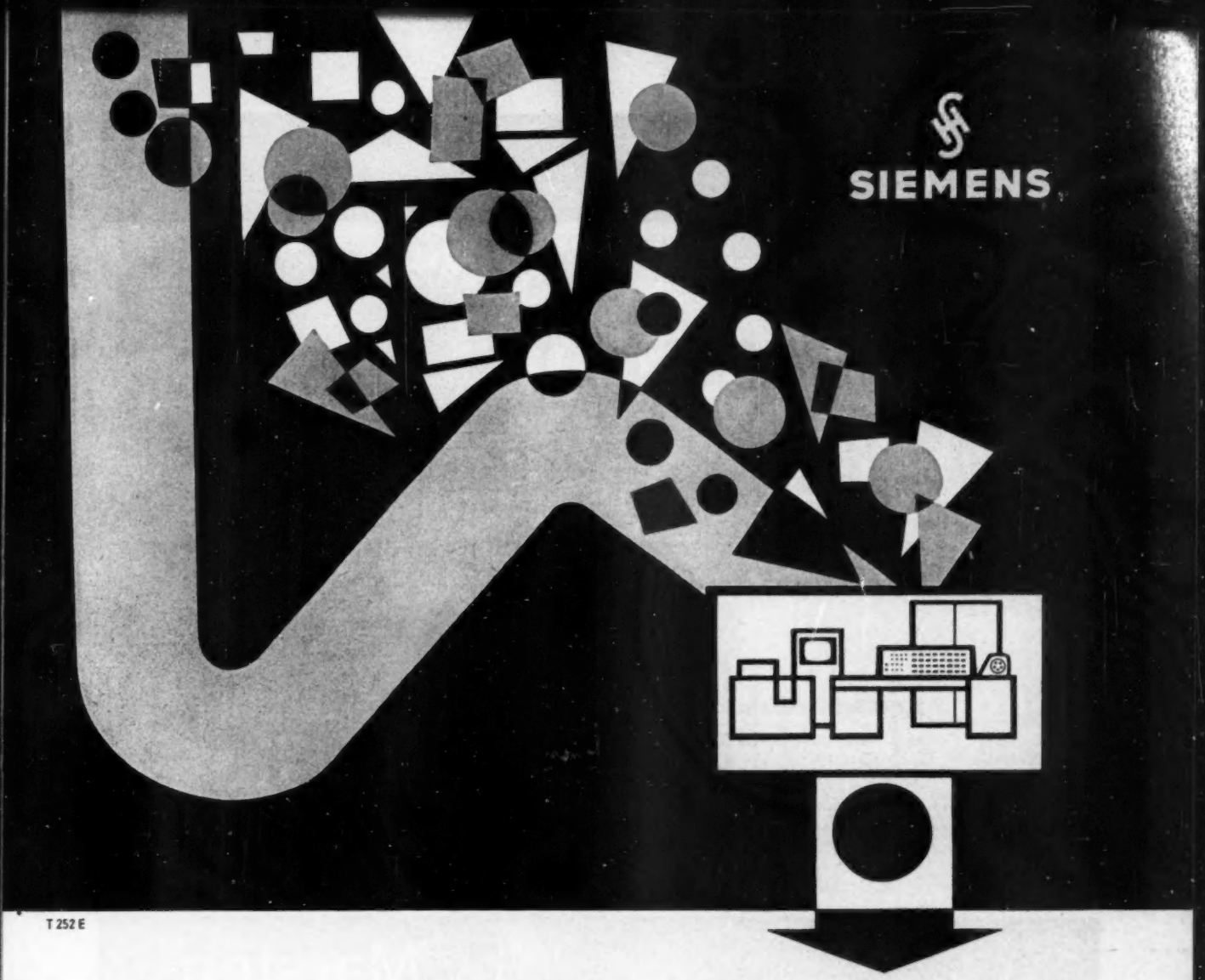
AUDIO TRIODE-PENTODE TYPE ECL86 is the title of a leaflet describing the design and construction of two stereophonic amplifier circuits based on this valve. Full constructional details (including two versions of the 10W amplifier using a printed circuit), response curves and test results are given for each circuit. Copies of this leaflet, ref. TP 456, are available from Mullard Ltd, T.S.D., Mullard House, Torrington Place, London, W.C.1.

WAYNE KERR-GERTSCH RATIO TRANSFORMERS is the title of a brochure describing twenty-six of the Company's ratio transformers and incorporating seven engineering papers on the theory and applications of this type of instrument. The brochure also contains many mechanical drawings, circuits, tables and detailed technical descriptions of the instruments. Copies of this brochure are available from Wayne Kerr Laboratories Limited, 44 Coombe Road, New Malden, Surrey.

"WIRELESS WORLD" DIARY 1962 is published by T. J. & J. Smith Ltd in conjunction with "Wireless World" and contains 80 pages of reference material, plus the usual diary pages. Information included in the diary includes the addresses of over 150 radio and allied organizations in this country and abroad; tabulated details of the world's television standards and the countries using them; dimensions for the elements of aerials for television and v.h.f. sound broadcasting; tabulated connexions for transistors and some 300 current receiving valves; channels and frequencies of U.K. television stations and graphical and letter symbols used in radio. The diary measures 4¼in by 3¼in and costs 4s. 10d. with Rexine cover or 6s. 10d. with leather cover (postage 4d.) and is available from Smith and Walker (Stationery) Ltd, 12 Hanover Square, London, W.1.

PRACTICAL GUIDE TO METROSIL is a new publication concerning the "Metrosil" non-linear resistors and associated technical information. Copies are available from the Instrumentation Division, Scientific Apparatus Department, A.E.I. Ltd, Barton Dock Road, Urmston, Manchester.

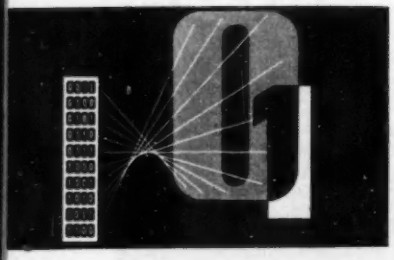
BAKELITE LAMINATED FOR GEARS is the title of a new edition of a publication by Bakelite Ltd and will be of interest to designers and engineers. This illustrated booklet describes the physical and mechanical properties of the material, the applications to which it is suited, installation principles, and gives all the relevant formula and data. Requests for copies of this publication should be addressed to the Company at 12-18 Grosvenor Gardens, London, S.W.1.



T 252 E

Tomorrow's Production Capacity

Current ideas are evaluated at industrial development centers to plan a line of products that will tomorrow be placed in quantity production. The solution of these problems depends on the availability of a considerable mass of valid data. Fruitless experimentation and time-consuming roundabout methods are too costly and impede progress. Electronic computer systems installed at a central point operate reliably at high speed to furnish exact results. These new, highly capable machines are tomorrow's guarantee that production capacity will be used to the full.



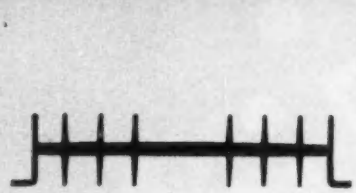
The Siemens Model 2002 Data Processing System

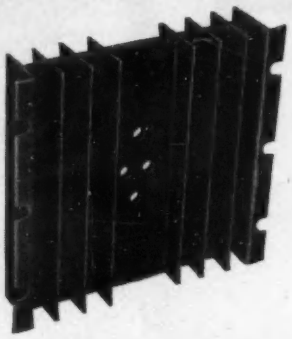
is of universal applicability and its unitized construction makes it readily adaptable to all problems. Its decisive advantages are: high operating speed, readily expandable storage capacity, fast input and output units. The Siemens data processing system 2002 can be expanded to keep pace with increasing problems and requirements.

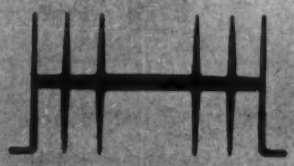
Computer specialists are available to customers at all times: the worldwide sales network of the Siemens organization is a guarantee for efficient customer service.

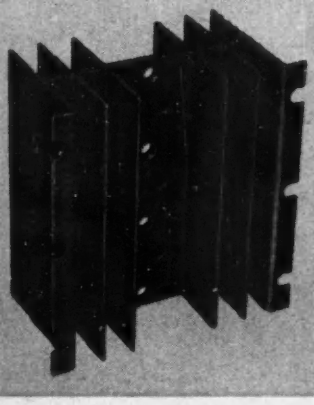
SIEMENS & HALSKE AKTIENGESELLSCHAFT
WERNERWERK FÜR TELEGRAFEN- UND SIGNALTECHNIK, MÜNCHEN

EE 40 142 *for further details*









by Marston

MAR 308

Standard heat-sinks

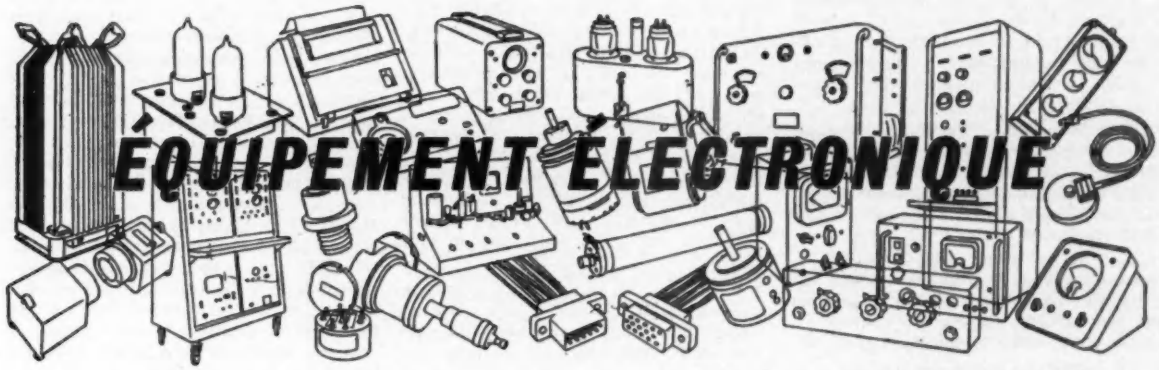
A wide range of power transistors and related semi-conductor devices can be efficiently cooled at low cost with Marston Standard Heat-Sinks. These inexpensive heat-sinks use the principle of natural convection.

Two basic shapes give flexibility in meeting thermal and installation problems. Either the high or low fin type is available in 9 different lengths. This gives a selection of 18 heat-sinks with thermal resistances from 1°c/watt to 3½°c/watt in free air.

Detailed performance figures and specifications are available on request.

ICI

MARSTON EXCELSIOR LTD
(a subsidiary company of Imperial Chemical Industries Ltd)
Armley Road, Leeds
(Head Office: Fordhouses, Wolverhampton)



ÉQUIPEMENT ÉLECTRONIQUE

Une description basée sur des renseignements fournis par les fabricants de nouveaux organes, accessoires et instruments d'essai

Traduction des pages 818 à 823

HORLOGE PILOTÉE PAR QUARTZ

P.T.S. Electronics Ltd, 96 Horsenden Lane, Greenford, Middlesex

(Illustration à la page 818)

Cet appareil comporte un cristal de quartz de 10 Hz et son degré de précision est d'environ 3 parties/10^6.

La fréquence est divisée par quatre décades transistorisées en impulsions de 1 seconde. Ces impulsions sont amplifiées, puis injectées à 6 bancs de compteurs en anneau à tubes de déclenchement à cathodes froides, qui actionnent 6 numicators en série, indiquant les secondes, les minutes et 12 heures ou 24 heures.

L'alimentation principale est entièrement stabilisée, un bloc d'alimentation à part étant inclus pour actionner les circuits à transistors.

Le réglage de temps s'effectue en commutant l'impulsion d'une seconde en heures, puis en minutes, puis en secondes, une position de maintien étant prévue pour arrêter l'horloge à n'importe quel moment voulu.

La tension de sortie alimente un imprimeur numérique tandis qu'une impulsion de 50 Hz entraîne des minuteries asservies synchrones de type courant.

EE 40 751 *pour plus amples renseignements*

CONDENSATEURS AU POLYSTYRÈNE

The Plessey Company Ltd, Vicarage Lane, Ilford, Essex

(Illustration à la page 818)

La Division des Résistances et Condensateurs de la Société Plessey vient d'annoncer l'introduction d'une nouvelle série de condensateurs au polystyrène à tolérance réduite. Les obstacles précédents à l'emploi du polystyrène comme diélectrique ont été surmontés dans une grande mesure par les nouvelles méthodes perfectionnées de fabrication qui ont amélioré le rapport capacité/volume.

Les condensateurs au polystyrène non blindés, du type courant, sont normalement limités à un plafond de température maximum de 78°C en raison du risque de déformation à mesure que l'on s'approche du degré de température amollissante. La mise sous moulage des condensateurs réduit le risque de déformation et la limite de température nominale peut être portée à 85°C.

La gamme de capacités de la nouvelle série va de 10pF à 0,22μF. Il existe des condensateurs de valeurs supérieures allant jusqu'à 0,5μF sous forme de types non enrobés. Une série de types en boîtiers d'aliminium, couvrant les valeurs de capacité plus élevées est également livrable.

Les tensions de travail pour les types sous moulage et sans moulage sont de 125, 350, 500, 750 et 1 000V. Il existe également des types sous moulage pour le fonctionnement à 2kV.

Les condensateurs au polystyrène se caractérisent par une résistance élevée à l'isolement et un facteur réduit de puissance. Les valeurs caractéristiques des nouveaux condensateurs produits par la Société Plessey sont de 10^6 Mégohms et 0,005 respectivement.

EE 40 752 *pour plus amples renseignements*

TUBE CATHODIQUE A DOUBLE CANON

The M-O Valve Co. Ltd, Brook Green, London, W.6

(Illustration à la page 818)

La Societe M-O Valve vient d'ajouter à sa gamme de fabrications un nouveau tube cathodique accélérateur de post-déviation hélicoïdal et à double canon. Il s'agit d'un tube de 10 cm de diamètre, type 1000 F, pour les oscilloscopes universels où deux signaux indépendants sont affichés sur une base de temps commune.

La sensibilité de déviation dans la direction X est de 24 V/cm et dans la direction Y elle est de 14 V/cm, avec une tension de canon de 1,2 kV et une tension anodique finale de 4 kV. La largeur de la ligne est d'environ 0,4 mm.

Les deux canons balaient une fenêtre commune de 6,3 cm × 6,3 cm. Des connexions à broches latérales reliant des plaques de déviation, contribuent à la capacité d'entrée réduite. La longueur totale, à l'exclusion des broches de base, est de 34,8 cm ±0.5 cm.

EE 40 753 *pour plus amples renseignements*

TRANSISTORMÈTRE

Grundy & Partners Ltd, 3 The Causeway, Teddington, Middlesex

(Illustration à la page 818)

Cet appareil a été spécifiquement conçu pour répondre à la demande d'un transistormètre universel à prix réduit, pour le contrôle des fuites et des caractéristiques.

Le coffret est en fibre de verre, d'une grande robustesse et résistant à l'usure. L'instrument de mesure est incorporé à un mouvement de base de 100 μA avec des gammes commutées de 250 μA, 10 mA, 100 mA.

On peut utiliser les deux jeux de bornes dont il est muni pour équilibrer ou comparer deux transistors pnp ou npn ou des diodes, dans un minimum de temps et dans des conditions égales.

Il permet également de contrôler les batteries intérieures chargées, éliminant ainsi toute possibilité d'erreur due à une panne de batterie.

Les dimensions hors-tout de l'instrument sont de 27,94cm × 19,05cm × 8,89cm et son poids est de 0,75kg, batteries comprises.

Il est possible de mesurer la tension de fuite Icó et Ico au collecteur-émetteur et au collecteur-base respectivement, à un potentiel de 4,5V.

Le gain de courant beta peut être mesuré sur les transistors jusqu'à 800mW et l'appareil donne une indication raisonable pour les transistors d'une puissance élevée. La tension au collecteur—émetteur est fixe à 4,5 V.

On peut faire varier le courant d'entrée de base au moyen d'une gamme préréglée de 10,50, 100 et 500 μA. Un commutateur à bouton poussoir permet d'augmenter le courant de base requis d'un incrément de 1/10.

Les diodes sont contrôlées dans le sens conducteur, en faisant passer un courant allant jusqu'à 10 mA, dépendant de la résistance directe. Le courant inverse est contrôlé à un potentiel de 9V.

EE 40 754 *pour plus amples renseignements*

CONTRÔLEUR DE BORDS

Lancashire Dynamo Electronic Products Ltd, Rugeley, Staffordshire

(Illustration à la page 819)

Dans de nombreux procédés comportant la manipulation de tissus en bandes continues, il est nécessaire d'enrouler les tissus sur des mandrins. Au fur et à mesure de l'accroissement des vitesses d'enroulement, il devient de plus en plus difficile d'éviter les déviations de la bande et, par conséquent, de maintenir des bords nets sur l'ensemble du rouleau.

L'appareil de contrôle des bords (série ERCI) fournit un moyen économique de contrôler les dispositifs correcteurs prévus pour régler la position du bord des tissus dans des limites très étroites. L'appareil comprend un élément de vision photoélectrique en forme de "U," par lequel le tissu passe, ainsi qu'un élément de contrôle à distance fixé au mur. Deux photocellules observent le bord de la bande continue, le système étant conçu de manière à ce que l'une des cellules s'éteigne tandis que l'autre s'éclaire lorsque la position est correcte. Si le bord du tissu se déplace, le sens de la déviation est indiqué par les photocellules et, après un délai de temps réglable, les dispositions correctrices sont mises en train. Après avoir fonctionné pendant une période de temps prédéterminée, le système correcteur est arrêté et l'appareil vérifie à nouveau la position du tissu, répétant cette opération jusqu'à ce que le bord du tissu soit rétabli à la position correcte sous la tête de vision.

L'appareil ERCI prévoit le réglage du "secteur mort" dans une gamme de 4:1 et sa précision est de ±0,079cm lorsqu'il est réglé à la sensibilité optimum. La durée des temps de "correction" et "d'observation" est réglable de 0,3 à 3 secondes et deux têtes de vision sont prévues, dont l'une a une profondeur de "gorge" de 7,62cm et l'autre de 15,24cm.

EE 40 755 *pour plus amples renseignements*

AMPLIFICATEUR QUADRIPOLAIRE

English Electric Valve Company Ltd. Chelmsford, Essex

La English Electric Valve Company Ltd annonce l'introduction d'un amplificateur quadripolaire de 400 MHz (tube d'Adler) pour les applications nécessitant un facteur de bruit très réduit. Le tube comporte une solénoïde de concentration et il peut être fourni sur demande avec un bloc d'alimentation connexe. Grâce à ce nouveau tube, la gamme d'amplificateurs quadripolaires fabriqués par la Société English Electric comprend maintenant le type N1036, fonctionnant dans la région de 200 MHz, le tube N1037 à 600 MHz ainsi que le type N1044.

Le N1044 est un dispositif à champ transversal dans lequel un faisceau électronique réagit à un champ d'hyperfréquences, transversal au parcours normal du faisceau.

Dans les conditions de grand signal d'entrée, le tube est coupé et cela assure une protection complète à tous les étages suivants. La paralysie du circuit ou le temps de rétablissement sont extrêmement courts après l'application d'une surcharge de signal d'entrée excessive.

Un gain de 20dB est fourni avec une largeur de bande de 50 MHz par points de gain de 3dB. Le facteur de bruit est inférieur à 2dB dans une largeur de bande d'au moins 25MHz et le tube a une puissance de sortie de saturation de 50μW. La fréquence centrale du N1044 est de 408MHz et le tube fonctionne avec un champ de concentration magnétique de 147 gauss.

Le bloc d'alimentation fournit un courant continu stabilisé à la solénoïde ainsi que l'alimentation en courant continu aux électrodes du tube et la puissance de pompe hyperfréquences. Le panneau frontal comprend des dispositifs de mesure permettant de mesurer le courant du faisceau du tube, le courant de la cathode, le courant de structure et les tensions des électrodes. Le panneau frontal est également muni de commandes permettant de régler le niveau de pompe et la fréquence de pompe dans des limites déterminees.

L'incorporation du bloc d'alimentation permet, en effectuant les connexions appropriées à l'alimentation d'entrée secteur et de signal, d'englober l'appareil de manière permanente ou provisoire dans des installations existantes ou nouvelles comme amplificateur à faible niveau de bruit. Les applications des amplificateurs quadripolaires comprennent les amplificateurs de tête de radars, les circuits d'entrée pour les systèmes de liaison radioastronomique et de diffusion troposphérique, ainsi que comme amplificateurs moyenne fréquence pour équipement millimétrique.

EE 40 756 *pour plus amples renseignements*

GENERATEUR DE FONCTIONS TRÈS BASSE FRÉQUENCE

Advance Components Ltd, Roebuck Road, Hainault, Ilford, Essex

(Illustration à la page 819)

Le générateur de fonctions t.b.f. type SG.88 est fondamentalement un dispositif optico-mécanique. Dans ce générateur, le circuit oscillateur ordinaire est remplacé par des disques rotatifs transparents interchangeables, balayés par un faisceau étroit de lumière. Sur chaque disque est imprimé un diagramme opaque représentant, sous forme de coordonnées polaires, la forme d'onde ou la fonction devant être produites. La gamme de formes d'ondes est virtuellement illimitée. Il suffit que la fonction dont chaque forme d'onde découle soit à valeur unique et à répétition. Le sens de la rotation du disque peut être changé de manière à inverser la séquence de temps de la forme d'onde de sortie.

La fréquence de sortie est à variation continue, allant de 0.005 Hz jusqu'à un maximum nominal de 50 Hz. En augmentant le nombre de dessins complets du disque, la limite de fréquence supérieure peut être augmentée de manière à dépasser plusieurs fois la valeur nominale.

L'accélération du disque sur les deux gammes inférieures de fréquences autorise un départ presque instantané à partir de n'importe quel point prédéterminé de la forme d'ondes. La périphérie du disque est étalonnée en degrés à cet effet.

Des dispositifs de balayage sont prévus dans les deux gammes de fréquences supérieures, afin de donner une estimation rapide de la réponse de l'appareil en cours d'essai. Le balayage de fréquence commence à n'importe quelle fréquence préréglée et se poursuit de facon logarithmique jusqu'à la limite supérieure de fréquences de la gamme.

EE 40 757 *pour plus amples renseignements*

GÉNÉRATEUR DE SIGNAUX BASSE FRÉQUENCE

Airmec Ltd, High Wycombe, Buckinghamshire

(Illustration à la page 819)

Le générateur de signaux b.f. type 252, de la Société Airmec, a été conçu pour la production de signaux d'ondes sinusoïdales pures et d'une stabilité élevée dans la gamme de fréquences de 30 Hz à 300 kHz.

L'oscillateur se compose d'un circuit à pont de Wien avec commande d'amplitude de réaction à thermistor suivi d'un amplificateur push-pull de contre-réaction. L'accord se fait au moyen d'un condensateur variable et couvre la bande de fréquences en quatre gammes de décades avec une précision d'étalonnage de ±1% ±1 Hz. La stabilité de fréquence à long terme est supérieure à 0,1% — 1 Hz dans la gamme de fréquences, et la variation de stabilité en fonction de la tension d'alimentation est d'environ 0,02% à 1 kHz pour une variation de 10%.

Un transformateur de puissance de sortie, équilibré et à écran, fournit des

tensions de sortie équilibrées ou déséquilibrées à une impédance de 600 Ohms. La construction du circuit est telle que l'impédance de sortie demeure constante, quelle que soit la fréquence ou le réglage d'atténuation, et la sortie est contrôlée par un voltmètre à diode piézoélectrique. La tension de sortie peut être aisément rendue parfaitement flottante en supprimant un chaînon extérieur sur le panneau frontal, et dans cet état elle pourra résister à un courant continu de 300 V ou à un courant alternatif de pointe à la terre.

Une commande de sortie assure la variation régulière de la sortie dans la gamme de l'appareil de mesure. En liaison avec un atténuateur à plots, elle permet de régler le niveau de sortie à n'importe quelle valeur, de moins de 1 mV à 15 V en circuit ouvert, avec une précision de ±0,2 dB par plot, ±0,3 dB pour l'ensemble du niveau de sortie. Les fluctuations du niveau de sortie dans la gamme entière de fréquences de l'appareil sont d'environ ±0,5 dB, s'élevant à ±1 dB dans le réglage d'atténuation de 0 dB avec une charge résistive de 600 Ohms.

EE 40 758 *pour plus amples renseignements*

POMPE A VIDE ÉLEVÉ

Mullard Ltd, Mullard House, Torrington Place, London, W.C.1

(Illustration à la page 820)

La pompe Penning VPP-5 vient d'être ajoutée à la gamme des dispositifs à vide élevé de la Société Mullard. Cette pompe, dont le fonctionnement est continu, est basée sur le principe de la jauge Penning, dans laquelle les électrons oscillent entre les cathodes froides. Un champ magnétique, perpendiculaire à la direction du flot des électrons, fait passer ces derniers par des voies en spirale pendant qu'ils oscillent dans le champ électrostatique formé par les cathodes et l'anode. Les ions produits par ces électrons sont accélérés vers les cathodes et libèrent de nouveaux électrons, cette action combinée étant auto-entretenue.

La pompe VPP-5 comprend de nombreux éléments à électrodes Penning en parallèle, utilisant des cathodes au titanium ordinaire de chaque côté d'un nid d'anodes. Durant le fonctionnement, le titanium jaillit de la cathode vers les anodes, formant ainsi de nouvelles surfaces qui fixent les gaz très activement. La durée de la pompe dépend de la quantité de titanium dans la cathode pour la pulvérisation et elle est estimée à 10 000 heures pour une pression de 10^{-} torr.

L'action de pompage de la VPP-5 débute à une pression de 5×10^{-6} torr. et se poursuit jusqu'à ce qu'une pression minima de 10^{-11} torr. soit atteinte. Dans cette gamme, la vitesse de pompage pour l'air est de 51 sec.

La pompe VPP-5 est enfermée dans un coffret en acier inoxydable muni d'un scellement céramique. Chaque pompe est fournie avec son propre aimant, qui peut être retiré durant la "cuisson". La pompe est reliée à un système à vide au moyen d'une bride et d'un scellement métallique démontable. Le scellement a un orifice de 1,905 cm et il peut être cuit jusqu'à une température maxima de 500°C.

EE 40 759 *pour plus amples renseignements*

DISPOSITIF A BOUTONS POUSSOIRS ÉCLAIRÉ

Telephone Manufacturing Co. Ltd, Martell Road, West Dulwich, London, S.E.21

(Illustration à la page 820)

Un nouveau dispositif éclairé à boutons poussoirs pour la commutation de lumière a été réalisé par la Telephone Manufacturing Co. Ltd.

Livrable sous forme à verrouillage, à non-verrouillage et a inter-verrouillage, le nouveau dispositif peut être utilisé pour les communications aussi bien que le matériel de dépouillement de données où les charges de contact maximales ne dépassent pas 300 mA.

Les dispositifs peuvent être fournis avec boutons poussoirs ronds ou rectangulaires, en nylon blanc ou noir et pour bandes de commutation à une, deux, dix ou douze directions. Une lampe de type téléphonique est incorporée au corps du bouton poussoir—ce qui assure une économie d'espace considérable—et les lentilles d'éclairage offrent un choix de cinq couleurs.

Le corps du bouton-poussoir est en nylon et des contacts d'argent jumelés sont utilisés sur tous les jeux de ressorts, qui sont prévus pour double ou quadruple permutation.

Les dimensions totales de ces nouveaux dispositifs sont de 5,71 cm × 1,508 cm × 3,19 cm. La distance minima entre pointes est de 1,58 cm.

EE 40 760 *pour plus amples renseignements*

ENCODEUR MAGNÉTIQUE

Ketay Ltd, Eddes House, Eastern Avenue West, Romford, Essex

(Illustration à la page 820)

Un encodeur angulaire de dimensions réduites, doté d'un synchro-montage BU-ORD format 18, réalisé par la United Aircraft Corporation, est maintenant livré par Ketay Limited, du Groupe de Sociétés Plessey.

Ce nouvel encodeur à couple réduit, qui est un des plus simples conçus jusqu'ici, donne des indications claires en code Gray à 10 000 tours/minute. L'entraînement d'arbre permet la rotation à droite ou à gauche pour le comptage par l'élément magnétique non-contactant, cependant que les circuits de sortie sont conformes à la demande du client.

Prévu pour remplacer les encodeurs du type à balais, avec lesquels il est interchangeable, l'appareil a l'avantage d'une longue durée et d'une action rapide dans des conditions de fonctionnement ne convenant pas aux encodeurs à balais. Il a été spécialement mis au point pour l'encodage à la position d'arbre et asservie pour une résistance faible ou moyenne, ainsi que pour les applications multitours tant simples qu'à grande résistance.

EE 40 761 *pour plus amples renseignements*

MULTIPLICATEUR DE FRÉQUENCE

Distributed by: Aveley Electric Ltd, Ayron Road, Aveley Industrial Estate, South Ockendon, Essex

(Illustration à la page 820)

Un multiplicateur de fréquence décupleur type XVD, fabriqué par Rohde & Schwartz, est actuellement vendu dans le Royaume-Uni par la Société Aveley Electric Limited.

Grâce à cet instrument, des fréquences de 3 à 30 mHz peuvent être décuplées sans ambiguité, étant donné que tout facteur de multiplication autre que 10 est exclu.

L'amplitude du signal est indiquée avec précision sur le tableau d'un appareil de mesure et elle est réglée par un atténuateur. L'appareil permet également d'effectuer la modulation d'amplitude extérieure et intérieure.

Le fréquence de la modulation intérieure est de 1 kHz et la modulation extérieure va de 30 Hz à 3 kHz, avec une profondeur de modulation à variation continue de 0 à 90%.

L'instrument fonctionne également comme oscillateur à marche libre dans la gamme de fréquences de 30 à 300 MHz.

EE 40 762 *pour plus amples renseignements*

BROUILLEUR TÉLÉPHONIQUE

Distributed by: Westrex Co. Ltd, 152 Coles Green Road, London, N.W.2

(Illustration à la page 821)

La Société Westrex annonce qu'elle vient d'être nommée distributeur pour le Royaume-Uni du téléphone de sécurité Delcon. Il s'agit d'un brouilleur vocal électronique entièrement transistorisé, permettant des conversations téléphoniques parfaitement sures, avec n'importe quel type d'appareil téléphonique, extérieur ou intérieur, sans risque aucun d'être écouté.

Cet appareil fonctionne sur batterie et il est fixé sur le combiné téléphonique courant, et ne nécessite ni câblage ni pièces permanentes. Il brouille la conversation de manière à ce qu'elle ne puisse pas être comprise par toute personne autre que celle utilisant un appareil identique à l'autre bout de la ligne. Il est portatif et ne pèse que 703 g. On peut facilement le mettre dans un porte-documents ou dans un sac pour pouvoir l'employer lorsqu'on est loin de son bureau.

L'appareil est fourni sous forme de postes assortis codés, de façon à ce que chaque client ait son poste particulier qui ne pourrait être compris par tout autre acheteur d'un appareil semblable.

L'appareil est livrable en trois types, c. à d. pour le fonctionnement à bouton-poussoir, pour le fonctionnement entièrement automatique et pour radiotéléphone mobile à modulation de fréquence.

EE 40 763 *pour plus amples renseignements*

ÉTALON DE PHASE VARIABLE

Wayne Kerr Laboratories Ltd, 44 Coombe Road, New Malden, Surrey

(Illustration à la page 821)

Un étalon de phase variable permettant de déplacer la phase entre deux tensions autoproduites vers n'importe quel angle voulu, avec un degré de précision minima de ±0,05°, est fourni maintenant par Wayne Kerr Laboratories Ltd.

Fonctionnant dans trois gammes de fréquences réglables entre 150 Hz et 3 kHz, ce nouvel instrument, type VPS-1, produit deux tensions d'amplitude égale, différant en phase par n'importe quel angle entre 0° et 360°. La tension de référence a une amplitude fixe de 50 V efficaces tandis que la sortie vectorielle, qui peut être déplacée en phase par incréments d'une minute d'arc, a une amplitude maxima de 50 V efficaces et peut être atténuée par plots de 50 mV.

Une particularité intéressante du VPS-1 est la production précise de vecteurs de tension, la tension de phase connue par rapport à la tension de référence étant obtenue en calculant les composantes déwattées et en phase, puis en faisant la somme de ces vecteurs.

L'appareil est entièrement autonome, ne nécessitant aucun équipement extérieur pour l'étalonnage ou le fonctionnement, et il est fourni dans un coffret ou prêt pour le montage sur baie.

EE 40 764 *pour plus amples renseignements*

PHASEMÈTRE

Dawe Instruments Ltd, Western Avenue, Acton, London, W.3

(Illustration à la page 821)

Le phasemètre type 630 est un instrument entièrement transistorisé pour mesurer la différence de phase entre deux signaux électriques dans la gamme des basses et très basses fréquences.

Le canal de référence comme celui de signaux sont reliés aux atténuateurs de courant dont la sortie alimente, à son tour, des circuits d'équilibrage, suivis de circuits d'amplification et de formation qui actionnent des circuits bistables dont les sorties sont différenciées afin d'actionner des impulsions en direction positive avec le même rapport que celui des excursions en direction positive des signaux d'entrée. Les impulsions de l'un des canaux branchent un autre circuit bistable tandis que celles de l'autre canal le débranchent. Le signal de forme d'onde rectangulaire qui en résulte a un rapport repère/espace directement proportionnel à la différence de phase des signaux d'entrée. Ce signal est intégré et appliqué à un appareil de mesure à cadre mobile, dont l'échelle est directement étalonnée en degrés angulaires de 0° à 360°. Pour faciliter la lecture lorsque les signaux sont presqu'en phase, un circuit de déphasage de 180° peut être choisi et les résultats peuvent être lus sur une échelle de 180°-0°-180°.

L'appareil a une gamme de fréquences de 1 Hz à 25 kHz. Les atténuateurs assurent soit une sensibilité à faible tension à une impédance d'entrée élevée soit l'inverse, la valeur allant de 30 à 300 V efficaces dans 10 mégohms, de 0,03 à 0,3 V efficaces dans 10 kiloohms. Avec des signaux équilibrés et en utilisant l'échelle de 0 à 360°, la précision est supérieure à ±3° au-dessus de 10 Hz.

Huit batteries type U11 rendent l'appareil pleinement autonome et suffisent à un fonctionnement d'environ 40 heures. L'appareil incorpore également un bloc d'alimentation pour le fonctionnement de 100 à 125 V et de 200 à 250 V courant secteur.

EE 40 765 *pour plus amples renseignements*

AMPLIFICATEUR C.C

Fenlow Electronics Ltd, Springfield Lane, Weybridge, Surrey

Un amplificateur de courant continu à transistors, d'une conception très simple, a été mis au point pour assurer une faible dérive sans avoir recours aux méthodes de correction à "chopper", ainsi que pour donner un excursion de tension de sortie plus étendue que ce n'est le cas habituellement pour le matériel à transistors. L'amplificateur Fenlow, type A.101, a été étudié pour fonctionner jusqu'à une température de 55°C et son impédance d'entrée est de 13 kiloohms. Le gain peut être réglé entre quatre et plusieurs centaines, en changeant simplement une résistance à réaction extérieure. La largeur de bande pour un gain de 20 est d'environ 1 kHz. La sortie fournit une excursion de tension de +30 à −30 V dans une charge de 20 kiloohms, ou une excursion légèrement plus réduite dans une charge pouvant atteindre un minimum de 5 kiloohms. 5 mV/h constituent une valeur de dérive caractéristique relative à l'entrée lorsque l'amplificateur est utilisé intérieurement. Il existe également une commande pour le contrôle de zéro.

EE 40 766 *pour plus amples renseignements*

BLOCS D'ALIMENTATION A TRANSISTOR

J. Langham Thompson Ltd, 176 High Road, Bushey Heath, Hertfordshire

(Illustration à la page 821)

La société J. Langham Thompson Limited a enrichi sa série de blocs d'alimentation transistorisés à basse tension. Ces appareils, originellement conçus pour les applications "incorporées", ont fait l'objet d'un soin particulier en ce qui concerne le montage et les dimensions. Les trois nouvelles gammes, dont les valeurs nominales sont de 20 VA, 30 VA et 60 VA, peuvent être montées en groupe de 5, 4 et 3 respectivement, derrière des panneaux standard de 48,2 cm. Un coffret métallique perforé assure une protection adéquate pour le fonctionnement sur banc d'essai.

Tous les bloc sont entièrement protégés contre les court-circuits et les surcharges au moyen de circuits électroniques brevetés et dans le cas des blocs de 30 VA, le réglage complémentaire s'effectue automatiquement lorsque la surcharge est supprimée.

Des tensions fixes de 5 à 60 V peuvent être fournies à des courants déterminés par les valeurs maxima VA des trois gammes de base, et un élément de 1½ A permet la variation de tension continue entre 4 et 12,5 V. Des méthodes de réglage double sont appliquées dans les éléments de 30 VA et 60 VA, afin d'assurer un réglage exceptionnellement précis et une plus grande efficacité. Dans le cas des éléments à 20 VA, on a attaché beaucoup d'importance à l'exiguité des dimensions et une sortie de puissance bien réglée est assurée par un élément ne mesurant que 8,25 cm × 8,89 cm × 20,32 cm.

Les méthodes de double réglage autorisent de grandes oscillations de tension d'entrée, tout en maintenant des tensions de sortie constantes.

La sortie, qui est entièrement exempte de phénomènes transitoires, ne comporte que 1 mV efficace de bourdonnenent et l'impédance de source se réduit à un minimum de 0,01 ohms pour la plupart des modèles.

EE 40 767 *pour plus amples renseignements*

CONTRÔLEURS DE ROTATION

Pentechnique Ltd, Imperial Lane, Cheltenham, Gloucester

(Illustration à la page 822)

Ces appareils ont été conçus pour émettre un signal d'alarme lorsqu'un arbre contrôlé (ou tout mouvement linéaire ou de va-et-vient) ralentit ou s'arrête. Les impulsions obtenues de l'arbre, au moyen de n'importe lequel des divers types de transducteurs magnétiques Pentechnique, maintiennent un relais dans le contrôleur de rotation d'arbre dans un état d'excitation. Lorsque l'arbre cesse de tourner, le relais se désamorce et les contacts de ce dernier actionnent des signaux d'alarme, des lumières avertisseuses ou d'autres signaux de contrôle. L'appareil est entièrement muni de dispositifs semiconducteurs et il comporte également un bloc d'alimentation permettant le fonctionnement à partir d'une alimentation secteur normale.

Quoique cet appareil soit généralement prévu pour l'emploi avec des capteurs magnétiques, il existe des versions pour l'emploi avec des contacts de commutateur et des capteurs photoélectriques.

Des versions spéciales peuvent être fournies pour la commutation à des vitesses d'arbre spécifiques et d'autres modifications comportent des relais alternatifs, des étages de sortie à transistors de puissance (pour la mise en action directe de petites solénoïdes), des circuits à retard de rejet et d'attraction variables et des alimentations pour différentes tensions secteur.

EE 40 768 *pour plus amples renseignements*

COMMUTATEUR A VIDE

Ferranti Ltd, Hollinwood, Lancashire

(Illustration à la page 822)

Un nouveau commutateur à vide, conçu principalement pour la commutation de circuits d'impulsions à tension élevée de modulateurs de radar, vient d'être réalisé par Ferranti Limited. Ce commutateur a été mis au point pour répondre à la demande d'un composant permettant de changer facilement les durées d'impulsions dans les installations de radar aéroportées.

Le commutateur type 13VSBI comporte une enveloppe à vide en verre et en métal contenant deux contacts, dont l'un est mobile et l'autre fixe, tous deux étant isolés de l'extrémité à la terre, de manière à résister à une tension d'impulsion maxima de 15 KV. Le contact mobile est actionné au moyen d'une solénoïde sur charge à ressorts, qui maintient les contacts fermés. Le commutateur est normalement fermé et les contacts ne se déplacent que d'environ 0,5 mm.

Les valeurs nominales de ce commutateur "arrêt-marche" sont: tension d'impulsion maxima 15 kV; courant d'impulsion maximum: 100 A; tension d'essai de courant continu 30 kV; temps de fonctionnement maximum 5 m/sec; résistance de contact maximum (à la position fermée) 0,02 Ohms; capacité maximum entre les contacts (à la position ouverte) 1,5 pF. Les valeurs nominales de la solénoïde sont: 24 V alimentation c.c.; résistance de bobinage; 20 ohms ±10%; courant d'attraction maximum 1 A; courant de retention maximum 100 mA. Ces valeurs nominales s'appliquent à des pressions ambiantes allant jusqu'à un minimum de 560 mm Hg et le commutateur est en mesure de résister aux essais normaux de chocs, vibrations et centrifuges effectués pour le matériel électronique de bord non pressurisé. Le commutateur a été prévu pour fonctionner en l'absence de courant ou de tension. La diélectrique à vide assure que la commutation accidentelle, jusqu'aux valeurs nominales totales, ne résulte pas en un endommagement permanent.

Le longueur hors tout est de 15,24 cm, son diamètre est de 2,54 cm et son poids est de 178 g.

EE 40 769 *pour plus amples renseignements*

BLOC D'ALIMENTATION DOUBLE

Solartron Laboratory Instruments Ltd, Cox Lane, Chessington, Surrey

(Illustration à la page 822)

Le tout dernier modèle de bloc d'alimentation produit par la Société Solartron est le type AS 1164, qui comprend des alimentations "flottantes" doubles, de 0 à 30 V, ayant chacune une capacité de 1 A. Les sorties sont réglables indépendamment par incréments de 0,1 V au moyen de la commutation à décades. Elles peuvent être utilisées séparément comme alimentations positive et négative. commutées pour le fonctionnement en parallèle afin de donner une capacité de 2 A, reliée en série pour assurer une alimentation à dérivations de 0 à 60 V ou reliée dos à dos pour fournir ±30 V − 0 − ±30 V. La précision du réglage de tension est de ±2% ±2 mV.

Chaque bloc a des sélecteurs de limite de surcharge à part (25, 50, 100, 250, 500 mA, 1 A) et il est muni d'instruments de contrôle de courant. Un dispositif de commande proportionnelle entièrement électronique fournit le moyen de protéger, non seulement le bloc d'alimentation, mais aussi le circuit qu'il alimente. Des avertisseurs de surcharge sont prévus pour chaque alimentation. Pour le fonctionnement en parallèle, on a prévu un jeu de commandes principales de niveau de sortie, mais les sélecteurs de limite de courant demeurent en fonctionnement et indépendants. Ce système permet de doubler la limite de surcharge jusqu'à 2 A, avec des réglages intermédiaires plus précis.

Le facteur de stabilité de chaque sortie est supérieur à 1000 : 1, le bourdonnement et le bruit est de 1 mV de crête à crête et la régulation est d'environ 0,1% pour une sortie maxima. L'impédance de sortie est inférieure à 0,35 ohms jusqu'à 1000 kHz.

EE 40 770 *pour plus amples renseignements*

INSTRUMENTS NUCLÉAIRES TRANSISTORISÉS

Nuclear Enterprises (G.B.) Ltd, Bankhead Medway, Sighthill, Edinburgh 11

(Illustration à la page 822)

La Société Nuclear Enterprises (G.B.) Limited a produit une série d'instruments nucléaires à circuit imprimé et transistorisés, en liaison avec A.W.R.E., Aldermaston.

Cette série se compose d'un certain nombre d'éléments fonctionnels, construits sous forme de blocs ordinaires de dimensions uniformes, et les éléments individuels peuvent être combinés en une variété de façons pour différentes recherches expérimentales. Quatre éléments peuvent être fixés, côte à côte, sur un rayon de baie standard de 48,2cm. Les dimensions de l'élément sont: 10,16cm de large × 15,24cm de haut × 25,4cm de long. Toutes les connexions d'alimentation et de signalisation passent par le panneau frontal. Des plaquettes de circuit imprimé à fiches sont utilisées pour faciliter l'entretien.

Amplificateur (NE5252)

Cet amplificateur a une amplification de tension totale de 1 000 fois, avec un étage préamplificateur pour l'impédance d'entrée élevée et trois étages amplificateurs avec une amplification de dix fois pour chacun d'eux. L'appareil se caractérise par une bonne linéarité et un facteur de bruit réduit. La puissance nécessaire est obtenue d'un appareil auxiliaire (NE 5352).

Analyseur (NE 5152)

Cet analyseur peut recevoir des impulsions aléatoires à une cadence d'environ 30 kp/s. On peut faire varier la largeur des voies par degrés de 0,2V, de 0,02 à 1.0V, et la gamme totale de commande de niveau d'amplitude d'impulsions est de 10V. Le niveau d'amplitude peut être balayé soit manuellement, soit par enregistreur de balayage utilisant une commande de polarisation extérieure (comme pour l'enregistreur modifié Honeywell-Brown) soit enfin, par un circuit de balayage intérieur permettant l'affichage sur un oscilloscope à mémoire.

Bloc d'alimentation (NE 5352)

Ce bloc fournit l'alimentation basse tension de plusieurs éléments aussi bien que l'alimentation très haute tension de photomultiplicateurs, tubes Geiger-Mueller ou compteurs proportionnels. La très haute tension est à variation continue de 500 V à 3 kV.

Compteur d'impulsions (NE 5452)

Cet appareil a une vitesse de comptage maximum de 30 kp/s. en 8 gammes. Des impulsions de moins de 10 comptages par seconde sont comptées sur un enregistreur électromécanique. La vitesse de comptage est indiquée sur un instrument de mesure.

Echelle de comptage (NE 5072)

Cette échelle de comptage a un temps de résolution de 1 μsec. et peut emmagasiner 10^9 comptages. L'affichage se fait par ampoules au néon jusqu'à 10^5 et, pour les quatre chiffres restants, sur un enregistreur électromécanique. Le temps de comptage peut être télécommandé, ainsi que le réglage, sauf pour l'enregistreur.

Minuterie (NE 5052)

Les impulsions de temps sont produites à intervalles d'une demi seconde par un chronomètre et on peut choisir les temps écoulés de 5 sec à 20 000 sec.

EE 40 771 *pour plus amples renseignements*

TUBES DE JONCTION À VIDE

Best Electrics Ltd, Ranelagh House, Felixstowe, Suffolk

(Illustration à la page 823)

Les tubes de jonction à vide, produits par la Société Best Electrics Limited, sont des convertisseurs thermiques spéciaux qui peuvent être utilisés comme étalons de conversion c.a./c.c. dans une gamme très étendue de fréquences. Ce sont, en fait, des dispositifs bimétalliques à vide.

Dans le tube de jonction à vide, la jonction est mise en contact thermique avec un filament de chauffage qui conduit le courant soumis à la mesure. La structure est enfermée dans une enveloppe de verre sous vide, afin de réduire les pertes de chaleur. Etant donné que la force électromotrice thermique produite est proportionnelle à la température de jonction, elle sera également proportionnelle, à son tour, au carré du courant de chauffage.

En mesurant la force électromotrice thermique sur un millivoltmètre étalonné, approprié à cet usage, on obtient une indication du courant appliqué. Si l'instrument est étalonné sur le courant

continu, le même étalonnage s'appliquera, dans les limites très étroites, au courant alternatif. De plus, vu que la jonction à vide mesure l'effet de chauffage du courant appliqué, les indications seront des valeurs efficaces réelles, quelle que soit la forme d'onde. Dans la gamme de fréquences de 25 Hz à 20 kHz, la jonction à vide est précise à 0,01% près pour toutes les mesures.

Trois modèles de jonctions à vide Best permettent, à eux trois, d'effectuer des mesures précises dans une gamme de fréquences s'étendant de moins de 0,1Hz à plusieurs centaines de mégacycles. Chaque modèle est fourni avec une variété de caractéristiques de chauffage, la plus sensible étant de 1 mA de courant de chauffage maximum.

EE 40 772 *pour plus amples renseignements*

DETECTEUR DE RETASSURES

Witton Electronics Ltd, Bickford Road, Witton, Birmingham 6

(Illustration à la page 823)

Ce détecteur électronique convient au contrôle du revêtement d'isolement des tuyaux métalliques, soit en cours de fabrication, soit en cours d'utilisation.

L'appareil comprend un élément électronique fonctionnant sur alimentation secteur ou sur batterie de 12 V, ainsi qu'une tête de balayage.

Lorsqu'on déplace la tête de balayage le long du tuyau, toute faille ou toute retassure dans le revêtement d'isolement est décelée par une décharge de haute tension non-meurtrière, produisant un signal audible et lumineux sur l'appareil de contrôle.

La tête de balayage peut être fournie avec des anneaux à fente ou interchangeables, s'adaptant à diverses dimensions de tuyaux.

EE 40 773 *pour plus amples renseignements*

COMPTEUR-VOLTMÈTRE NUMÉRIQUE

Southern Instruments Ltd, Frimley Road, Camberley, Surrey

(Illustration à la page 823)

Le compteur voltmètre numérique type M1155 mesure la tension de 1 mV à 500 V et la fréquence de 0,1Hz à 120 kHz pendant une période de comptage de 0,1 1 ou 10 secondes. Il mesure également les intervalles de temps, définis par des signaux électriques ou par des fermetures de contact, de 1 msec à 27,7 h. En outre, il fournit des impulsions d'horloge pilotées par quartz, de 0,1, 1 et 10 msec. et de 0,1 1 et 10 secondes. Pour toutes ces opérations, l'impédance d'entrée est d'un ordre élevé.

Un affichage brillant, avec un angle de vision étendu, est réalisé au moyen d'indicateurs directs du type à projection. Un système de verrouillage, déclenché momentanément, à la fin de chaque comptage, fournit un affichage continu et ininterrompu par la période de comptage.

L'instrument fonctionne sur courant secteur; il est compact, portatif et robuste, ce qui le rend également propre aux applications industrielles et de laboratoire.

EE 40 774 *pour plus amples renseignements*

CONTRÔLEUR GAMMA SÉLECTIF

Plessey Nucleonics Ltd, Weedon Road, Northampton

(Illustration à la page 823)

Plessey Nucleonics Limited vient de présenter un contrôleur gamma sélectif type PNI 1118, compact et pouvant déceler de petites quantités de matières radio-actives émettant des rayons gamma dans la gamme d'énergie de 10 keV à 1,5 MeV. Le contrôleur décèle ces rayons au moyen d'un compteur à scintillations suivi d'un analyseur d'amplitude d'impulsions à voie unique. Tous les circuits sont à transistors. Le contrôleur fonctionne sur batterie de véhicule ou sur secteur, il est facilement transportable et il est muni de six pieds de câble de connexion entre l'élément indicateur et la sonde de détection.

Les sondes de détection fournies couvrent les gammes de 10 à 60 keV, 50 à 300 keV et 250 keV à 1,5 MeV respectivement, et se composent de scintillateurs à l'iodure de sodium activés au thallium, montés à l'extrémité des tubes photomultiplicateurs. Le réglage de très haute tension s'effectue sur les sondes individuelles, et la connexion de n'importe quelle sonde règle automatiquement la très haute tension requise. L'alimentation varie de 500 à 1500 V. La polarisation de seuil est préréglée pour l'analyseur d'amplitude d'impulsions à voie unique et la largeur de voie est commutée pour donner des voies de 50, 25 et 10% dans les gammes de 10 à 60 keV et 50 à 300 keV et 0,25 à 1,5 MeV respectivement. Les largeurs de voies sont préréglées intérieurement.

EE 40 775 *pour plus amples renseignements*

Résumés des Principaux Articles

Un modulateur de phase basse fréquence utilisant les méthodes d'impulsions par W. D. Humpage

Résumé de l'article aux pages 772 à 777

L'auteur examine la réalisation d'un modulateur dont on peut faire varier la phase d'une porteuse d'onde sinusoïdale de 1592 kHz, conformément à une tension de modulation. La gamme de déphasage de la porteuse est de 450° et le décalage de linéarité du déphasage, en tant que fonction de l'ampleur d'une entrée de modulation, est inférieur à 1%. Cette linéarité est maintenue dans la gamme totale de déphasage de la porteuse, et pour des fréquences de modulation dans la bande de 0 à 10Hz.

Amplificateur de données transistorisé par H. Fuchs et K. B. Rhodes

Résumé de l'article aux pages 778 à 782

Cet article décrit le dessin d'un amplificateur de données transistorisé convenant à l'amplification de signaux microvolts de thermocouples, de transducteurs de pression et d'autres sources.

L'article traite des principales qualités exigées d'un amplificateur de données et décrit la façon dont a pu les remplir dans la réalisation en question.

Diodes de jonction au silicium utilisées comme condensateurs variables par J. Registrar

Résumé de l'article aux pages 783 à 787

L'auteur explique le mécanisme physique de la capacité apparaissant aux jonctions des semi-conducteurs. Des expressions sont indiquées qui définissent la largeur et la capacité de la couche d'arrêt pour diverses formes de jonction. Des méthodes sont proposées et le rapport existant entre la température et Q, pertes et capacité, est étudié. Enfin, diverses applications sont indiquées qui montrent l'utilisation des diodes au silicium comme condensateurs variables.

Un générateur de mire d'impulsions transistorisé par V. J. Philips et G. M. Saltmarsh

Résumé de l'article aux pages 788 à 791

Cet article décrit le projet et la construction d'un générateur de mire d'impulsions produisant à répétition une mire de huit impulsions binaires selon les réglages de huit commutateurs manuels.

Amplificateur basse fréquence de 50 watts à transistors par F. Butler

Résumé de l'article aux pages 792 à 796

Cet amplificateur, qui fonctionne sur secteur alternatif, a un gain total de 105 dB et il utilise quatre transistors de puissance dans un étage de sortie convenant au couplage direct à une charge de 15 ohms. Une distorsion réduite est assurée par l'emploi d'un montage mixte à réaction positive et à contre-réaction, cette dernière étant appliquée à trois étages push-pull. Dans la mesure du possible, le couplage direct entre étages a été utilisé afin d'économiser les composants et de stabiliser les conditions de travail des transistors. Une certaine contre-distorsion s'effectue dans les étages à niveau réduit afin d'assurer une réponse de fréquence égale lorsque l'amplificateur est utilisé avec un appareil d'accord radio pour hyperfréquences.

Réseaux de stabilisation optimum à transistors par J. D. Meindl et O. Pitzalis

Résumé de l'article aux pages 798 à 802

Les auteurs décrivent une théorie étendue en vue de la réalisation de circuits de stabilisation de courant continu à transistors, qui tient compte des paramètres $I_{(BO)}$, V_{BE} et h_{FE} des dispositifs sensibles à la température. Ils examinent les effets de variations de température d'alimentation et de résistance du circuit de stabilisation. Les tolérances des paramètres des transistors ainsi que les tolérances des résistances sont également prises en considération. Le circuit de stabilisation a été prévu pour une dissipation de courant minima.

Un détecteur sensible aux phases par G. Scantlebury

Résumé de l'article aux pages 803 à 805

L'auteur décrit un type de détecteur sensible aux phases où le signal de référence et le signal variable ont une borne commune pouvant être mise à la masse. Le nombre de composants exigés par ce détecteur est très limité, et il ne nécessite pas de transformateurs spéciaux à prise médiane. Conçu à l'origine pour déceler la sortie d'un pont à courant alternatif, il a demontré par la suite qu'il avait d'autres propriétés de valeur. Certaines de ces dernières sont examinées dans cet article et une analyse détaillée du cas général est donnée dans l'appendice.

Mesure de la luminescence par G. P. Burn

Résumé de l'article aux pages 806 à 807

Cet article décrit comment une très faible luminescence peut être mesurée en complant les impulsions de sortie d'un photomultiplicateur. L'appareil complet se compose du photomultiplicateur, de ses blocs d'alimentation et d'un préamplificateur, dont la puissance de sortie est transmise à un discriminateur de niveau d'impulsions et à une échelle de comptage.

Pellicules métalliques minces pour la mesure des ondes millimétriques par M. H. Cufflin

Résumé de l'article aux pages 808 à 810

En vue d'un projet de mesure d'ondes millimétriques, on a réalisé des disques réflecteurs et de couplage pouvant être utilisés dans les guides d'ondes circulaires. On a étudié l'utilisation des films métalliques " évaporés " sur des disques minces de verre et des détails sont donnés dans cet article sur les résultats obtenus avec les films métalliques à encoches et sans encoches.

ELEKTRONISCHE GERÄTE

Beschreibung neuer Bauelemente, Zubehörteile und Prüfgeräte auf Grund der von Herstellern gemachten Angaben.

Übersetzung der Seiten 606 bis 611

Quarzuhr

P.T.S. Electronics Ltd, 96 Horsenden Lane, Greenford, Middlesex

(Abbildung Seite 818)

Die Uhr benutzt ein 10 kHz-Quarz mit einer Genauigkeit von ungefähr 3×10^{-6}.

Diese Frequenz wird durch vier transistorisierte Dekaden auf 1 Sekunden-Impulse unterteilt. Diese Impulse werden verstärkt und sechs mit Kaltkathoden-Triggerröhren bestückten Ringzählerschaltungen zugeführt, die zur Anzeige von Sekunden, Minuten und 12 oder 24 Stunden sechs einreihig angeordnete Zahlenröhren betätigen.

Die Hauptstromversorgung ist vollstabilisiert; für die Transistor-Schaltungen ist eine getrennte Stromversorgung eingebaut.

Zur Zeiteinstellung werden erst die Stunden, dann Minuten und zuletzt Sekunden mit dem 1 Sekunden-Impuls beaufschlagt; durch eine Aussetzstellung kann die Uhr zu jeder beliebigen Zeit angehalten werden.

Ausgangsklemmen für Anschluss eines Digitaldruckers sowie ein 50 Hz-Impuls zum Antrieb von Standard-Synchrontochteruhren sind vorgesehen.

EE 40 751 *für weitere Einzelheiten*

Polystyrol-Kondensatoren

The Plessey Company Ltd, Vicarage Lane, Ilford, Essex

(Abbildung Seite 818)

Eine neue Polystyrol-Kondensatorenserie mit engen Toleranzen wird von der Kondensatoren- und Widerstandsabteilung der Plessey Company Limited angekündigt. Die früher bestehenden Beschränkungen bei der Verwendung von Polystyrol als Dielektrikum wurden weitgehend überwunden, und neue Herstellungsverfahren haben das Kapazitäts-Volumenverhältnis verbessert.

Ungeschützte Standard-Polystyrol-Kondensatoren sind normalerweise auf eine obere Temperaturgrenze von ungefähr 70° C beschränkt, da Gefahr besteht, dass mit Annäherung an die Erweichungstemperatur Deformierung eintritt. Umhüllung der Kondensatoren verringert die Deformierungsgefahr und erhöht die Nenngrenztemperatur auf 85° C.

Der Kapazitätsbereich der neuen Serie liegt von 10 pF bis zu 0,22 µF. Höhere Werte bis zu 0,5 µF sind in nichtumhüllter Ausführung lieferbar; eine Auswahl von Typen in Aluminiumbechern für höhere Kapazitäten steht auch zur Verfügung.

Die Betriebsspannungen für umhüllte und ungeschützte Typen sind auch für Betrieb bei 2 kV lieferbar.

Hoher Isolations-Widerstand und niedriger Verlustfaktor sind wichtige Kennzeichen der Polystyrol-Kondensatoren des neuen Plessey-Programms, für die 10^6 MΩ bzw. 0,005 als typische Werte gegeben werden.

EE 40 752 *für weitere Einzelheiten*

Zweistrahl-Oszillographenröhre mit Nachbeschleunigung

The M-O Valve Co. Ltd, Brook Green, London, W.6

(Abbildung Seite 818)

Die M-O Valve Company hat ihr Programm durch eine neue Zweistrahl-Oszillographenröhre mit spiralförmiger Nachbeschleunigung erweitert, und zwar die Type 1000 F mit 10 cm-Schirm für Mehrzweck-Oszillographen zur Darstellung von zwei unabhängigen Signalen mit gemeinsamem Zeitmassstab.

Die Ablenkempfindlichkeit in X-Richtung ist 24 V/cm und in Y-Richtung 14 C/cm bei einer Kanonenspannung von 1,2 kV und einer Gesamtanodenspannung von 4 kV. Die Zeilenbreite ist ungefähr 0,4 mm.

Die zwei Kanonen tasten ein gemeinsames Fenster von 6,3 × 6,3 cm ab. Seitenanschlüsse zu den Ablenkplatten tragen zur niedrigen Eingangskapazität bei. Die Gesamtlänge ausschliesslich der Sockelstifte ist 34,8 ±0,5 cm.

EE 40 753 *für weitere Einzelheiten*

Transistor-Tester

Grundy & Partners Ltd, 3 The Causeway, Teddington, Middlesex

(Abbildung Seite 818)

Der Bedarf für ein preisgünstiges Gerät zur Prüfung des Reststroms und Messung der Kennlinien von Transistoren lag dieser Entwicklung zugrunde.

Das aus Glasfaser hergestellte Gehäuse ist unnachgiebig und widerstandsfest. Der

eingebaute Anzeiger hat ein 100 μA-Messwerk mit umschaltbaren Bereichen für 250 μA, 1 mA, 10 mA und 100 mA.

Bei Benutzung der beiden vorgesehenen Klemmensätze können zwei pnp oder npn Transistoren oder Dioden mit dem geringsten Aufwand an Zeit unter genau denselben Bedingungen gepaart oder miteinander verglichen werden.

Die internen Batterien können unter Belastung gemessen werden, so dass Fehler durch Batterieausfall vermieden werden.

Bei Gesamtabmessungen von 28 × 19 × 9 cm wiegt das Gerät einschliesslich Batterien nur 795 g.

Die Kollektorrestströme I_{co}' mit offener Basis und I_{co} mit offenem Emitter können bei einer Spannung von 4,5 V gemessen werden.

Die Stromverstärkung β kann bei feststehender Kollektor-Emitterspannung von 4,5 V für Transistoren bis zu 800 mW gemessen werden, und für Transistoren höherer Leistung wird eine annehmbare Anzeige gegeben.

Der Eingangsstrom für die Basis kann über einen vorgewählten Bereich von 10, 50, 100 und 500 μA geändert werden; durch eine Drucktaste kann der gewählte Basisstrom um 10% erhöht werden.

Dioden werden in Durchlassrichtung mit einem vom Durchlasswiderstand abhängigen Strom von bis zu 10 mA geprüft. Der Sperrstrom wird bei einer Spannung von 9 V gemessen.

EE 40 754 *für weitere Einzelheiten*

Kantenführungsregler

Lancashire Dynamo Electronic Products Ltd, Rugeley, Staffordshire

(Abbildung Seite 819)

Bei vielen Arbeitsvorgängen, in denen Werkstoffe in Streifen- oder Bahnform verarbeitet werden, ist es erforderlich, das Material auf Dorne aufzuwickeln. Mit wachsender Wickelgeschwindigkeit wird es immer schwieriger, das Wandern der Streifen und Bahnen zu vermeiden und die "glatte" Kante für die volle Rolle aufrechtzuhalten.

Mit dem Kantenführungsregelgerät Serie ERC1 ist die Möglichkeit gegeben, die Steuerung von Stellgliedern, durch die die Materialkante innerhalb enger Grenzen positioniert wird, auf wirtschaftliche Weise vorzunehmen. Das Gerät besteht aus einem U-förmig ausgeführten fotoelektrischen Abtastkopf, durch den das Material läuft, und einem für Wandmontage ausgelegten Steuergerät. Zweifache Fotozellen beobachten die Kante des Streifens oder der Bahn; das System ist so angeordnet, dass bei korrekter Lage eine Zelle verdeckt und die andere beleuchtet ist. Wenn die Materialkante wandert, wird die Abwanderungsrichtung durch die Fotozellen angezeigt und die Regeltätigkeit nach vorwählbarer Verzögerung eingeleitet. Das Stellglied kommt nach einer vorgegebenen Zeitspanne zur Ruhe, und das Gerät prüft wieder die Bahnlage; dieser Regelablauf wiederholt sich, bis das Material unter dem Abtastkopf in der richtigen Position liegt.

Die Totzeit der Geräteserie ERC1 kann über einen Bereich von 4:1 eingestellt werden; bei Einstellung auf Höchstempfindlichkeit ist die Regelunsicherheit innerhalb ±0,8 mm., Verzögerungen für "Regeln" und "Beobachten" können zwischen 0,3 und 3 Sekunden vorgewählt werden. Die Abtastköpfe sind in zwei Ausführungen mit 76 mm und 152 mm Ausladung lieferbar.

EE 40 755 *für weitere Einzelheiten*

Vierpol-Verstärker

English Electric Valve Company Ltd, Chelmsford, Essex

Die English Electric Valve Company Limited kündigt einen 400 MHz-Vierpol-Verstärker (Adler-Röhre) für Verwendungszwecke an, die sehr geringe Rauschzahlen erfordern. Die Röhre wird mit der Fokussierspule und, wenn gewünscht, mit der zugehörigen Stromversorgung geliefert. Das Vierpol-Verstärker-Programm der English Electric besteht aus der N1036 für den 200 MHz-Bereich, der N1037 für den 600 MHz-Bereich und der neuen Röhre N1044.

Type N1044 ist ein Querfeldinstrument, in dem ein Elektronenstrahl mit einem quer zum normalen Weg des Strahls erzeugten HF-Feld zusammenwirkt.

Bei Anlegen eines grossen Eingangssignals setzt die Röhre aus und sichert dadurch die nachfolgenden Stufen. Schaltungsparalyse und Totzeit nach Überlastung mit einem übergrossen Eingangssignal sind äusserst kurz.

20 dB Verstärkung steht bei einer Bandbreite von 50 MHz (bis zu 3dB-Verstärkungspunkten) zur Verfügung. Über eine Bandbreite von mindestens 25 MHz liegt die Rauschzahl unter 2 dB; die Röhre hat eine Sättigungs-Ausgangsleistung von 50 μW. Die Mittelfrequenz der N1044 ist 408 MHz; die Röhre wird mit einem magnetischen Fokussierfeld von 147 Gauss betrieben.

Die Stromversorgung liefert eine stabilisierte Gleichspannung für die Magnetspule, Gleichspannungen für die Röhrenelektroden und die HF-Pumpleistung. Messgeräte auf der Frontplatte ermöglichen Messung des Röhrenstrahlstroms, Kathodenstroms, Strukturstroms und der Elektrodenspannungen. Pumppegel und -frequenz können innerhalb vorgegebener Grenzen von der Frontplatte aus geregelt werden.

Einschluss der Stromversorgung bedeutet, dass das Gerät durch Herstellung geeigneter Netz- und Signalverbindungen dauernd oder vorübergehend als rauscharmer Verstärker in neue oder bestehende Anlagen eingeschaltet werden kann. Zu den Verwendungszwecken der Vierpol-Verstärker gehören Radar-Mischköpfe, Eingangsschaltungen für Radioastronomie, Nachrichtensysteme mit troposphärischer Streuung und ZF-Verstärker für mm-Geräte.

EE 40 756 *für weitere Einzelheiten*

Funktionsgeber für sehr niedrige Frequenzen

Advance Components Ltd, Roebuck Road, Hainault, Ilford, Essex

(Abbildung Seite 819)

Der Funktionsgeber SG.88 für sehr niedrige Frequenzen beruht auf einem optisch-mechanischen System. In diesem Geber ist die herkömmliche Oszillatorschaltung durch eine auswechselbare, lichtdurchlässige, umlaufende Scheibe ersetzt, die von einem scharf gebündelten Lichstrahl abgetastet wird. Auf jede Scheibe ist ein lichtundurchlässiges Muster aufgedruckt, das die zu erzeugende Wellenform oder Funktion in Polarkoordinaten darstellt. Der Wellenformbereich ist praktisch unbegrenzt, da nur erforderlich ist, dass die Funktion einwertig ist und sich wiederholt. Zur Umkehr der Zeitfolge der Ausgangswellenform kann die Drehrichtung der Scheibe umgestellt werden.

Die Ausgangsfrequenz ist von 0,005 Hz bis zu einem nominellen Maximum von 50 Hz stufenlos regelbar. Durch Anordnung mehrerer vollständiger Muster auf der Scheibe kann der nominelle Höchstwert auf ein Vielfaches erhöht werden.

In den beiden niedrigen Frequenzbereichen ist ein selbsttätiger Durchlauf zur schnellen Schätzung des Frequenzgangs zu prüfender Geräte vorgesehen. Der Frequenzdurchlauf beginnt bei jeder beliebigen vorgewählten Frequenz und verläuft logarithmisch bis zur obersten Frequenzgrenze des Bereiches.

EE 40 757 *für weitere Einzelheiten*

NF-Signalgeber

Airmec Ltd, High Wycombe, Buckinghamshire

(Abbildung Seite 819)

Der Airmec-NF-Signalgeber 252 ist zur Erzeugung reiner und hochkonstanter Sinuswellensignale im Frequenzbereich 30 Hz ... 300 kHz ausgelegt.

Der Oszillator besteht aus einem Wien-Brückennetzwerk mit Thermistor-Gegenkopplungsamplitudenreglung, dem ein Gegentaktverstärker mit Gegenkopplung folgt; die Abstimmung erfolgt mittels eines Drehkondensators in vier Dekadenbereichen mit einer Eichgenauigkeit von ±1% ±1 Hz. Die langfristige Frequenzkonstanz über den Frequenzbereich ist besser als 0,1% ±1 Hz, und die Konstanz bei Netzschwankungen ist für Änderungen von 10% ungefähr 0,02%.

Einem abgeschirmten Ausgleichsübertrager können ausgeglichene und unausgeglichene Ausgänge bei 600Ω Impedanz entnommen werden; die Schaltung ist so ausgelegt, dass die Ausgangsimpedanz

unabhängig von Frequenz- und Abschwächereinstellung konstant bleibt; der Ausgang wird mittels eines Kristalldioden-Voltmeters überwacht. Nach Entfernung einer Brücke auf der Frontplatte steht der Ausgang erdfrei zur Verfügung und kann in diesem Zustand 300 V Gleich- oder Spitzenwechselspannung gegen Erde widerstehen.

Durch einen Ausgangsregler kann der Ausgang über den Gesamtbereich des Anzeigeinstruments stossfrei geändert werden. In Verbindungen mit einem Stufenabschwächer kann der Ausgang auf jeden beliebigen Leerlaufpegel von unter 1 mV bis zu 15 V mit einer Genauigkeit von ±0,2 dB pro Stufe und insgesamt ±0,3 dB eingeregelt werden. Über den gesamten Frequenzbereich sind die Ausgangspegelschwankungen ungefähr ±0,5 dB und steigen bis zu ± 1dB, wenn der Abschwächer bei 600 Ω ohmschem Abschluss auf 0 dB steht.

EE 40 758 *für weitere Einzelheiten*

Hochvakuumpumpe

Mullard Ltd, Mullard House, Torrington Place, London, W.C.1

(Abbildung Seite 820)

Eine neue Erweiterung des Mullard-Fertigungsprogramms von Ultra-Hochvakuumgeräten ist die Pennig-Pumpe VPP-5. Diese kontinuierlich arbeitende Pumpe stützt sich auf das Prinzip des Pennig-Manometers, in dem Elektronen zum Hin- und Herschwingen zwischen Kaltkathoden veranlasst werden. Ein senkrecht zum Elektronenstrom wirkendes Magnetfeld veranlasst die im elektrostatischen Feld zwischen den Kathoden und der Anode oszillierenden Elektronen, spiralförmige Wege zu durchlaufen. Diese Elektronen erzeugen Ionen, die auf die Kathoden hin beschleunigt werden und weitere Elektronen freisetzen; diese Kombinationswirkung ist selbsterregend.

Die Pumpe VPP-5 besteht aus vielen parallelgeschalteten Pennig-Elektroden, die gemeinsame Titankathoden an jeder Seite eines Anodenbündels benutzen. Während des Betriebes wird Titan von der Kathode auf die Anode abgetragen und bildet neue Oberflächen, die sehr aktiv verdampfen. Die Lebensdauer der Pumpe hängt von der Titanmenge ab, die zur Verdampfung an der Kathode zur Verfügung steht; bei einem Druck von 10^{-6} Torr wird sie auf 10 000 Stunden geschätzt.

Die Saugwirkung der VPP-5 beginnt mit einem Druck von 5×10^{-2} Torr und wird fortgesetzt, bis der Druck auf den niedrigen Wert von 10^{-11} Torr absinkt. Über diesen Bereich ist die Sauggeschwindigkeit für Luft 5 l/s.

Die VPP-5 ist in einem Gehäuse aus rostfreiem Stahl untergebracht und mit einer keramisch abgedichteten Metalldurchführung ausgerüstet. Jede Pumpe wird mit ihrem eigenen Magneten geliefert, der während des Austrocknens entfernt werden kann. Die Pumpe wird über einen Flansch und abnehmbare Metalldichtung mit dem Vakuumsystem verbunden. Die Dichtung hat eine 19 mm Öffnung und verträgt eine Höchsttemperatur von 500°C während der Wärmebehandlung.

EE 40 759 *für weitere Einzelheiten*

Leuchtdrucktasten

Telephone Manufacturing Co. Ltd, Martell Road, West Dulwich, London, S.E.21

(Abbildung Seite 820)

Eine neue Leuchtdrucktaste für Schwachstrom-Schaltzwecke ist jetzt von der Telephone Manufacturing Company Ltd erhältlich.

Die in verriegelnder, nichtverriegelnder und gegenseitig verriegelnder Form lieferbare neue Taste findet sowohl im Nachrichtenverkehr und in der Datenverarbeitung als auch in Test- und Steuergeräten Verwendung, soweit die maximale Kontaktbelastung 100 V bei 300 mA nicht übersteigt.

Die Tasten können mit runden oder viereckigen Druckknöpfen aus schwarzem oder weissem Nylon einzeln oder in zwei-, zehn- oder zwölfteiligen Tastenstreifen geliefert werden. Die im Druckknopfkörper eingebaute Fernsprecherlampentype ist raumsparend, und Leuchtsignallinsen sind in fünf verschiedenen Farben lieferbar.

Die Druckknopfkörper werden aus Nylon hergestellt, und für alle Federsätze, die für zwei oder vier Umschaltvorgänge erhältlich sind, werden doppelte Silberkontakte benutzt.

Die Gesamtabmessungen der neuen Tasten sind 57,15 × 15 × 31,75 mm. Der geringste Mittellinienabstand zwischen Tasten ist 15,875 mm.

EE 40 760 *für weitere Einzelheiten*

Magnetischer Drehgeber

Ketay Ltd, Eddes House, Eastern Avenue West, Romford, Essex

(Abbildung Seite 820)

Ein von der United Aircraft Corporation entwickelter sehr kleiner Drehgeber mit einem Synchroaufbau Bu-Ord Grösse 18 kann jetzt durch Ketay Limited, eine Firma der Plessey Gruppe, bezogen werden.

Der neue, ein niedriges Drehmoment erfordernde Geber ist einer der einfachsten bisher entwickelten und gibt bei 10 000 UPM eindeutige Information in Gray-Verschlüsselung. Der Schaftantrieb ermöglicht zum Zählen mittels eines nichtberührenden magnetischen Fühlers entweder rechts- oder linksläufige Drehung; Ausgangsschaltungen können Kundenwünschen entsprechend geliefert werden.

Der Geber wurde entwickelt, um Bürstendrehgebertypen zu ersetzen und ist gegen diese austauschbar. Er hat die Vorteile langer Lebensdauer und hoher Geschwindigkeit unter Bedingungen, für die der Bürstentyp nicht geeignet ist. Er ist besonders als Geber in Servosystemen und für Schaftpositionen bei niedriger oder mittlerer Auflösung und Verwendung für eine Umdrehung, wie auch für hohe Auflösung bei mehreren Umdrehungen konstruiert.

EE 40 761 *für weitere Einzelheiten*

Frequenzvervielfacher

Vertrieb: Aveley Electric Ltd, Ayron Road, Aveley Industrial Estate, South Ockendon, Essex

(Abbildung Seite 820)

Ein von Rhode & Schwarz hergestellter zehnfacher Frequenzvervielfacher kann jetzt in England von Aveley Electric Limited bezogen werden.

Mit diesem Gerät können Frequenzen von 3 ... 30 kc/s ohne Mehrdeutigkeit vervielfacht werden, da alle Multiplikationsfaktoren ausser 10 ausgeschlossen sind.

Die Signalamplitude wird auf einem Frontplatteninstrument genau angezeigt und mittels eines Abschwächers eingeregelt. Sowohl interne wie externe Amplitudenmodulation sind vorgesehen.

Die interne Modulationsfrequenz ist 1 kHz und die externe Modulation 30 Hz ... 3 kHz mit kontinuierlich von 0 ... 90% regelbarer Modulationstiefe.

Das Gerät kann auch als selbsterregter Oszillator über den Frequenzbereich von 30 ... 300 MHz eingesetzt werden.

EE 40 762 *für weitere Einzelheiten*

Geheimtelefonie

Vertrieb: Westrex Co. Ltd, 152 Coles Green Road, London, N.W.2

(Abbildung Seite 821)

Die Westrex Company gibt bekannt, dass sie den Vertrieb des Delcon-Sicherheitsfernsprechers für England übernommen hat. Es handelt sich um einen volltransistorisierten elektronischen Sprachverwürfler, der völlig geheime Fernsprechunterhaltungen mit externen und internen Fernsprechgeräten aller Art ohne Gefahr von Überhören ermöglicht.

Das batteriebetriebene Gerät wird ohne Verdrahtung oder Dauerbefestigung irgendwelcher Art an den herkömmlichen Fernsprechhörer gehalten. Es verwürfelt die Unterhaltung so, dass sie ausser von der Person am anderen Ende der Leitung, die ein identisches Gerät hat, von niemand verstanden werden kann. Das Gerät ist leicht und tragbar (680 g) und kann ausserhalb des Büros leicht in einer Akten- oder Handtasche transportiert werden.

Die Geräte werden in abgestimmten Sätzen geliefert, deren Verschlüsselung gewährleistet, dass jeder Kunde sein

eigenes privates Gerät hat, das nicht von einem anderen Käufer ähnlicher Geräte verstanden werden kann.

Das Gerät ist in drei Ausführungen lieferbar: mit Drucktasten, automatisch und für bewegliche FM-Radiofernsprecher.

EE 40 763 *für weitere Einzelheiten*

Veränderliches Phasennormal

Wayne Kerr Laboratories Ltd, 44 Coombe Road, New Malden, Surrey

(Abbildung Seite 821)

Ein veränderliches Phasennormal, das die Phasenverschiebung zwischen zwei selbsterzeugten Spannungen zu jedem gewünschten Winkel mit einer Mindestgenauigkeit von 0,05° ermöglicht, ist jetzt von Wayne Kerr Laboratories Limited lieferbar.

Dieses neue, als VPS-1 bezeichnete Gerät arbeitet über drei durchstimmbare Frequenzbereiche zwischen 150Hz und 3kHz und erzeugt zwei Spannungen gleicher Amplitude, deren Phase um einen beliebigen Winkel von 0°...360° verschieden ist. Die Bezugsspannung hat eine Festamplitude von $50V_{eff}$, während der Vektorausgang, dessen Phase in Stufen von einer Bogenminute verschoben werden kann, eine Höchstamplitude von $50V_{eff}$ hat, die in 50mV-Stufen abgeschwächt werden kann.

Interessant ist im VPS-1 die genaue Erzeugung der Spannungsvektoren, bei der die Spannung mit der in Hinsicht auf die Bezugsspannung bekannten Phase dadurch erzielt wird, dass erst die phasenstarren und Quadraturkomponenten erzeugt und dann diese Vektoren summiert werden.

Das Gerät ist völlig geschlossen, braucht keinen externen Zubehör für Eichung oder Betrieb und ist im Gehäuse oder für Gestelleinbau erhältlich.

EE 40 764 *für weitere Einzelheiten*

Phasenmesser

Dawe Instruments Ltd, Western Avenue, Acton, London, W.3

(Abbildung Seite 821)

Der Phasenmesser 630 ist ein volltransistorisiertes Gerät zur Messung der Phasendifferenz zweier elektrischer Signale im Ton- und Untertonbereich.

Sowohl Signal- wie Bezugskanal werden Stromabschwächern zugeführt, deren Ausgänge in Abgleichschaltungen gespeist werden, denen Verstärkungs- und Formgebungsschaltungen folgen, die bistabile Schaltungen treiben, deren Ausgänge differenziert werden, und denen positivgehende Impulse mit denselben Phasenbeziehungen entnommen werden, die die positivgehenden Abweichungen des Eingangssignals haben. Die Impulse des einen Kanals schalten eine weitere bistabile Schaltung "ein", die des anderen schalten sie "aus". Das entstehende Rechteckwellenformsignal hat ein der Phasendifferenz des Eingangssignals direkt proportionales Tastverhältnis. Es wird integriert und an ein Drehspulinstrument gelegt, dessen Skala direkt in Winkelgraden von 0° ... 360° geeicht ist. Zur Erleichterung der Ablesung für nahezu phasengleiche Signale kann eine Phasenverschiebung um 180° eingeschaltet werden, und die Ergebnisse werden auf einer 180°-0°-180° Skala abgelesen.

Das Gerät hat einen Frequenzbereich von 1 Hz ... 25 kHz. Die Abschwächer geben entweder Niederspannungsempfindlichkeit bei hohem Eingangswiderstand oder umgekehrt, wobei sich die Werte von 30 ... 300 V_{eff} in 10 mΩ bis zu 0,03 ... 0,3 V_{eff} in 10 kΩ erstrecken. Mit ausgeglichenen Signalen und bei Benutzung der Skala für 0° ... 360° ist die Genauigkeit über 10 Hz besser als ±3°.

Mit acht Batterien Ull, die für 40 stündigen Betrieb ausreichen, ist das Gerät in sich geschlossen. Ein Netzanschluss für Spannungen von 100...125V und 200...250V ist eingebaut.

EE 40 765 *für weitere Einzelheiten*

Gleichspannungsverstärker

Fenlow Electronics Ltd, Springfield Lane, Weybridge, Surrey

(Abbildung Seite 821)

Ein einfacher transistorisierter Gleichspannungsverstärker wurde entwickelt, der ohne Benutzung der Zerhackerkorrektur geringe Drift aufweist und einen grösseren Steuerbereich für die Ausgangsspannung hat als in Transistorgeräten üblich ist. Der Fenlow-Verstärker A.101 ist für Temperaturen bis zu 55°C ausgelegt, hat einen Eingangswiderstand von 13kΩ und eine Verstärkung, die durch Änderung eines externen Gegenkopplungswiderstandes leicht von vier bis zu mehreren hundert geregelt werden kann; für eine Verstärkung von 20 ist die Bandbreite ungefähr 1kHz. Der Ausgang gibt eine Spannungsaussteuerung von +30 bis −30V in einen Abschluss von 20kΩ, oder eine etwas geringere Aussteuerung in einen Widerstand bis zu 5kΩ herunter. Ein typischer, auf den Eingang bezogener Driftwert ist 5mV/h, wenn der Verstärker unter Innenbedingungen benutzt wird. Eine Null-Stellung ist vorgesehen.

EE 40 766 *für weitere Einzelheiten*

Transistor-Stromversorgungsgeräte

J. Langham Thompson Ltd, 176 High Road, Bushey Heath, Hertfordshire

(Abbildung Seite 822)

J. Langham Thompson Ltd hat das Fertigungsprogramm für niederspannige Transistor-Stromversorgungen erweitert.

Die Geräte sind in erster Linie für Einbau bestimmt, und daher wurde der Montage und den Abmessungen besondere Aufmerksamkeit geschenkt. Die drei neuen Serien sind für 20 VA, 30 VA und 60 VA bemessen und können in Gruppen von 5, 4 bzw. 3 hinter 19 Zoll-Standard-Frontplatten montiert werden. Ein Gehäuse aus gelochtem Blech gibt ausreichenden Schutz, wo Betrieb auf einem Tisch erwünscht ist.

Alle Geräte sind durch eine patentierte elektronische Schaltung gegen Kurzschluss und Überlastung geschützt, und die 30 VA-Serie wird selbsttätig zurückgestellt, sowie die Überlastung nicht mehr besteht.

Festspannungen zwischen 5 und 60 V können für Stromabgaben, die der Höchstnennleistung der drei Grundserien entsprechen, vorgesehen werden; ein Gerät für 1,5 A hat kontinuierliche Spannungsreglung von 4 ... 12,5 V. Die in den 30 VA- und 60 VA-Geräten benutzte doppelte Reglertechnik ergibt ausserordentlich gute Reglung und erhöhte Wirksamkeit. Bei der 20 VA Type wurde besonders auf ein kleines Gerät Wert gelegt, das bei Abmessungen von nur 82,5 × 89 × 203 mm einen gut regulierten Ausgang abgibt.

Die benutzte doppelte Reglertechnik gewährleistet konstantgehaltene Ausgangsspannungen selbst bei grossen Schwankungen der Eingangsspannung.

Der von Einschwingvorgängen völlig freie Ausgang hat eine Restwelligkeit von nur 1 mV_{eff}, und für die meisten Modelle ist die Quellenimpedanz mit 0,01 Ω sehr niedrig.

EE 40 767 *für weitere Einzelheiten*

Drehwächter

Pentechnique Ltd, Imperial Lane, Cheltenham, Gloucester

(Abbildung Seite 822)

Drei Geräte, die Warnung geben, sowie eine überwachte umlaufende Welle (oder jede beliebige pendelnde oder geradlinige Bewegung) langsamer läuft oder anhält, wurden entwickelt. Von einem beliebigen magnetischen Wandler des Pentechnique-Programms abgegebene Impulse halten ein Relais im Drehwähler im erregten Zustand. Wenn der Schaft nicht mehr läuft, fällt das Relais ab, und seine Kontakte betätigen ein Alarmsignal, Warnungslampen oder andere Kontrollsignale. Es werden durchweg Halbleiter benutzt, und das Gerät kann mittels einer eingebauten Stromversorgung vom normalen Netz gespeist werden.

Trotzdem die Geräte normalerweise für magnetische Wandler gedacht sind, können Ausführungen für Schalterkontakte und fotoelektrische Abnehmer geliefert werden.

Sonderausführungen für bestimmte Umlaufgeschwindigkeiten und andere Abwandlungen einschliesslich Ausrü-

stung mit alternativen Relais, Leistungstransistorendstufen (für direkte Betätigung von kleinen Magnetspulen), Einzugs- und Freigabeschaltungen mit variabler Verzögerung und Netzanschluss für verschiedene Netzspannungen sind lieferbar.

EE 40 768 *für weitere Einzelheiten*

Vakuumschalter

Ferranti Ltd, Hollinwood, Lancashire

(Abbildung Seite 822)

Ferranti Limited gibt die Entwicklung eines neuen Vakuumschalters bekannt, der hauptsächlich zum Umschalten von hochspannungsimpulsbildenden Netzwerken in Radarmodulatoren bestimmt ist. Dieser Schalter befriedigt den Bedarf für ein Bauelement, durch das Impulslängen in Bordradargeräten leicht geändert werden können.

Der Schalter 13VSBI besteht aus einem evakuierten Glas- und Metallkolben, in dem sich zwei Kontakte befinden (ein feststehender und ein beweglicher), die beide für eine maximale Impulsspannung von 15 kV gegen Erde isoliert sind. Der bewegliche Kontakt wird durch eine gegen eine Feder wirkende Magnetspule betätigt, die die Kontakte zusammenhält. Der Schalter ist normalerweise geschlossen; die Kontakte bewegen sich nur um 0,508 mm.

Die Nennwerte dieses Ein-Ausschalters sind: Impulshöchstspannung 15 kV; Impulshöchststrom 100 A; Prüfgleichspannung 30 kV; max. Ansprechzeit 5 ms; max. Kontaktwiderstand (geschlossen) 0,02Ω; Kapazität zwischen den offenen Kontakten max. 1,5 pF. Die Nennwerte der Magnetspule sind: Betriebsspannung 24 V Gleichstrom; Spulenwiderstand 20 Ω ± 10%; max. Ansprechstrom 1 A; max. Haltestrom 100 mA. Diese Nennwerte sind für Umgebungsdrücke bis zu 560 mm Hg herunter gültig; der Schalter kann allen normalerweise in Tests für nicht unter Druck stehende elektronische Geräte auftretenden Stössen, Schwingungen und Schleuderkräften widerstehen. Er ist für Betätigung in Abwesenheit von Strom oder Spannung ausgelegt. Das Vakuumdielektrikum gewährleistet, dass zufälliges Schalten bis zu den vollen Nennwerten keinen bleibenden Schaden hervorruft.

Der 152,4 mm lange Schalter hat einen Durchmesser von 25,4 mm und wiegt 170 g.

EE 40 769 *für weitere Einzelheiten*

Doppelstromversorgung

Solartron Laboratory Instruments Ltd, Cox Lane, Chessington, Surrey

(Abbildung Seite 822)

Die neuste Solartron-Stromversorgung AS1164 besteht aus zwei erdfreien Versorgungen von 0 ... 30 V mit je 1A Kapazität. Die Ausgänge sind unabhängig voneinander durch Dekadenschaltung in Stufen von 0,1 V einstellbar. Sie können entweder getrennt als positive und negative Spannungen, in Parallelschaltung für 2A Stromabgabe, in Serienschaltung für 0 ... 60 V mit Abgriff oder gegeneinandergeschaltet für ±30 V−0−±30 V benutzt werden. Die Einstellgenauigkeit der Spannungen ist ±2% ±2mV.

Jede Versorgung hat einen vorwählbaren Überlastungsschutz (25, 50, 100, 250, 500mA, 1A) und Stromüberwachungsanzeiger. Ein vollelektronisches Proportional-Regelsystem schützt nicht nur die Stromversorgungen, sondern auch die abgeschlossenen Schaltungen. Jede Stromversorgung ist mit Überlastungsanzeigern ausgerüstet. Für Parallelbetrieb besteht ein übersteuernder Satz von Ausgangspegelreglern; jedoch bleiben die Strombegrenzungswähler wirksam und unabhängig. Dadurch wird der Überlastungsschutz mit feinerer Zwischenreglung auf 2 A verdoppelt.

Der Stabilitätsfaktor ist für jeden Ausgang besser als 3000 : 1, Restwelligkeit und Rauschen 1 mV_{ss} und Reglung bei Höchstleistung ungefähr 0,1%. Die Ausgangsimpedanz liegt bis zu 100 kHz unter 0,35 Ω.

EE 40 770 *für weitere Einzelheiten*

Transistorisierte kernphysikalische Geräte

Nuclear Enterprises (G.B.) Ltd, Bankhead Medway, Sighthill, Edinburgh 11

(Abbildung Seite 822)

Nuclear Enterprises (G.B.) Limited hat in Zusammenarbeit mit A.W.R.E. in Aldermaston eine Reihe transistorisierter kernphysikalischer Geräte mit Leiterplattentechnik entwickelt.

Die Serie besteht aus einer Anzahl funktioneller Geräte in Gehäusen gleicher Abmessungen; die einzelnen Geräte können in verschiedener Weise zur Durchführung der jeweiligen Untersuchungen zusammengestellt werden. Vier Geräte passen nebeneinander in ein Fach eines 19 Zoll-Gestells; die Geräte sind 101,6 mm breit, 152,4 mm hoch und 254 mm tief. Verbindungen für Stromversorgung und Signale werden auf der Frontplatte hergestellt. Zur vereinfachten Wartung werden einsteckbare gedruckte Schaltungen benutzt.

Verstärker NE5252

Der Verstärker hat eine 1 000fache Gesamtspannungsverstärkung mit einer Vorverstärkerstufe für hohen Eingangswiderstand und drei Stufen mit jeweils zehnfacher Verstärkung. Das Gerät hat gute Linearität und geringes Rauschen. Die Stromversorgung wird dem Netzgerät NE5352 entnommen.

Analysator NE5152

Der Analysator kann wahllose Impulse mit ungefähr 40 kHz verarbeiten. Die Kanalbreite kann in 0,2 V-Schritten von 0,2...1,0 V eingestellt werden; der Gesamtbereich des Reglers für die Impulshöhe ist 10 V. Der Höhenpegel kann (a) manuell, (b) durch einen Kurvenschreiber mit externer Vorspannungsreglung (wie der abgewandelte Honeywell-Brown-Schreiber), oder (c) durch eine interne Kippschaltung für eventuelle Anzeige auf einer Speicher-Oszillographenröhre überstrichen werden.

Netzgerät NE5352

Das Netzgerät liefert sowohl die Niederspannung für mehrere Geräte, als auch die Hochspannung für Photovervielfacher, Geiger-Müller-Zählrohre oder Proportionalzähler. Die Hochspannung ist von 500 V...3 kV kontinuierlich regelbar.

Ratemeter NE5452

Das Ratemetergerät hat eine Höchstzählrate von 30 kHz in 8 Bereichen. Unter 10 Impulsen pro Sekunde erfolgt die Zählung elektromechanisch. Die Zählrate wird auf einem Instrument angezeigt.

Untersetzer NE5072

Der Untersetzer hat eine Totzeit von 1 μs und kann 10^9 Impulse speichern. Bis zu 10^5 erfolgt die Anzeige mit Neonlampen und für die letzten vier Stellen durch elektromagnetischen Zähler. Fernsteuerung der Zählzeit ist möglich, und auch die Rückstellung mit Ausnahme des Zählwerkes kann ferngesteuert werden.

Schaltuhr NE5052

Zeitimpulse werden von einer Stoppuhr in Halbsekundenintervallen hervorgerufen und Zeitfolgen von 5...20 000 s können vorgewählt werden.

EE 40 771 *für weitere Einzelheiten*

Vakuum-Thermoumformer

Best Electrics Ltd, Ranelagh House, Felixstowe, Suffolk

(Abbildung Seite 823)

Die von Best Electrics Limited hergestellten Vakuum-Thermoumformer sind Spezialelemente, die als Übertragungsnormal für Wechsel- und Gleichströme über einen sehr grossen Frequenzbereich dienen. Sie sind eigentlich vakuum-umhüllte Bimetallelemente.

In Vakuum-Thermoumformern steht die Verbindungsstelle in thermischem Kontakt mit dem Heizfaden, durch den der zu messende Strom fliesst. Das System ist in einen evakuierten Glaskolben eingebaut, um Wärmeverluste auf ein Minimum zu bringen. Da die hervorgerufene Thermo-EMK der Verbindungsstellentemperatur proportional ist, wird sie auch dem Quadrat des Heizstroms proportional sein.

Messen der Thermo-EMK mittels eines in geeigneter Weise geeichten Millivoltmeters gibt daher eine Anzeige des durchfliessenden Stroms. Die Gleichspannungseichung des Messgerätes gilt innerhalb sehr enger Grenzen auch für Wechselspannungen. Da der Thermoum-

former ausserdem die Heizwirkung des durchfliessenden Stroms misst, erfolgt die Anzeige unabhängig von der Wellenform in wahren Effektivwerten. Für alle Messungen im Bereich von 25Hz... 20kHz ist der Thermoumformer genau innerhalb 0,01%.

Drei Muster der Best-Vakuum-Thermoumformer ermöglichen zusammen genaue Messungen über einen Frequenzbereich von unter 0,1 Hz bis zu mehreren hundert Megaherz. Jedes Muster ist für verschiedene Heizströme lieferbar; die empfindlichsten sind für einen maximalen Heizstrom von 1 mA ausgelegt.

EE 40 772 *für weitere Einzelheiten*

Nachweis feiner Löcher

Witton Electronics Ltd, Bickford Road, Witton, Birmingham 6

(Abbildung Seite 823)

Dieses elektronische Nachweisgerät für nadelfeine Löcher ist zur Inspektion der isolierenden Beschichtung von Metallrohren während der Fertigung oder auf der Strecke geeignet.

Das Gerät besteht aus einem elektronischen Teil für Netz- oder 12 V-Batteriebetrieb und einem Tastkopf.

Wenn der Tastkopf vom Inspektor längsweise über das Rohr bewegt wird, wird jeder Fehler oder jedes feine Loch in der isolierenden Schicht durch eine nicht lebensgefährliche Hochspannungsentladung nachgewiesen, die im Kontrollgerät ein hörbares oder aufleuchtendes Signal gibt.

Der Tastkopf kann mit auswechselbaren oder Spaltringen für verschiedene Rohrgrössen geliefert werden.

EE 40 773 *für weitere Einzelheiten*

Digitalvoltmeter-Zähler

Southern Instruments Ltd, Frimley Road, Camberley, Surrey

(Abbildung Seite 823)

Type M.1155 ist ein Digitalvoltmeter und -zählgerät, das Spannungen von 1 mV...500 V und Frequenzen von 0,1 Hz...120 kHz mit Zählperioden von 0,1 s, 1 s oder 10s misst. Durch elektrische Signale oder Schliessen von Kontakten begrenzte Zeitspannen von 1 ms... 27,7h können ebenfalls gemessen werden. Ferner gibt das Gerät quarzgesteuerte Taktimpulse von 0,1 ms, 1 ms, 10 ms, 0,1 s, 1 s und 10 s ab. Für alle Arbeitsweisen ist der Eingangswiderstand hoch.

EE 40 774 *für weitere Einzelheiten*

Selektive Gammaüberwachung

Plessey Nucleonics Ltd, Weedon Road, Northampton

(Abbildung Seite 823)

Plessey Nucleonics Limited kündigt einen kompakten, selektiven Gammamonitor Type PNI 1118 an, der kleine Mengen radioaktiver Materialien, die Gammastrahlen im Energiebereich von 10 keV...1,5 MeV abgeben, nachweisen kann. Der Nachweis dieser Strahlen erfolgt mittels eines Szintillationszählers, dem ein Einkanal-Impulshöhenanalysator nachgeschaltet ist. Alle Schaltungen sind mit Transistoren bestückt. Der Monitor wird vom Netz oder einer Fahrzeugbatterie betrieben, kann leicht transportiert werden und ist mit einem 2 m langen Verbindungskabel zwischen Anzeigegerät und Nachweiskopf ausgerüstet.

Die lieferbaren Nachweisköpfe überstreichen die Bereiche 10...60 keV, 50... 300 keV bzw. 250 keV...1,5 MeV und bestehen aus mit Thallium aktivierten Natrium-Jod-Szintillatoren, die an einen Photovervielfacher angebaut sind. Reglung der Hochspannung erfolgt an den einzelnen Messköpfen, und Anschalten eines beliebigen Kopfes stellt automatisch die erforderliche Spannung ein. Die Stromversorgung ist von 500...1 500 V regelbar.

Die Schwellenvorspannung für den Einkanal-Impulsamplitudenanalysator ist vorgegeben; die Kanalbreite ist umschaltbar, so dass für den 10...60 keV, 50... 300 keV bzw. 0,25...1,5 MeV Bereich 50%, 25% und 10%-Kanäle zur Verfügung stehen. Kanalbreiten sind intern eingestellt.

EE 40 775 *für weitere Einzelheiten*

Zusammenfassung der wichtigsten Beiträge

Ein tonfrequenter Phasenmodulator mit Impulstechnik von W. D. Humpage

Zusammenfassung des Beitrages auf Seite 778-782

Die Konstruktion eines Modulators, in dem die Phase einer sinusförmigen Trägerfrequenz von 1592Hz entsprechend einer Modulationsfrequenz geändert werden kann, wird beschrieben. Der Phasenverschiebungsbereich des Trägers ist 450°, und die Abweichung der Phasenverschiebungslinearität als Funktion der Grössenordnung des Modulationseingangs ist unter 1%. Diese Linearität wird für Modulationsfrequenzen im 0 . . . 10Hz-Band über den ganzen Phasenverschiebungsbereich des Trägers aufrecht erhalten.

Ein transistorisierter Messwertverstärker von H. Fuchs und K. B. Rhodes

Zusammenfassung des Beitrages auf Seite 778-782

Der Beitrag beschreibt die Konstruktion eines transistorisierten Messwertverstärkers, der für Verstärkung von Mikrovoltsignalen geeignet ist, die von Thermoelementen, Druckgebern und ähnlichen Quellen abgegeben werden.

Die Haupterfordernisse für einen Messwertverstärker werden besprochen, und es wird gezeigt, wie sie durch die vorliegende Konstruktion erfüllt werden.

Silizium-Flächendioden als veränderliche Kondensatoren von J. Registrar

Zusammenfassung des Beitrages auf Seite 783-787

Die physikalischen Zusammenhänge der an den Halbleiterflächen auftretenden Kapazität werden erläutert. Ausdrücke werden gegeben, die die Breite und Kapazität der Sperrschicht für die verschiedenen Flächenformen bestimmen. Verfahren zur Messung dieser Eigenschaft werden vorgeschlagen, und die gegenseitige Abhängigkeit von Q, Verlusten und temperaturabhängiger Kapazität wird besprochen. Abschliessend wird an Hand einiger Beispiele die Verwendung von Halbleiterdioden als veränderliche Kondensatoren beschrieben.

Ein transistorisierter Impulsmuster-Geber von V. J. Phillips und G. M. Saltmarsh

Zusammenfassung des Beitrages auf Seite 788-791

Dieser Beitrag beschreibt Konstruktion und Aufbau eines Impulsmuster-Gebers, der gemäss der Einstellung von acht manuell betätigten Schaltern wiederkehrende Muster von acht Binär-Impulsen erzeugt.

50W-Transistor-Tonfrequenzverstärker von F. Butler

Zusammenfassung des Beitrages auf Seite 792-796

Der vom Wechselstromnetz betriebene Verstärker hat eine Gesamtverstärkung von 105 dB und eine mit vier Leistungstransistoren bestückte Endstufe, die für direkte Kopplung an einen 15Ω-Abschluss geeignet ist. Ein niedriger Klirrfaktor wird durch Kombination von Mit- und Gegenkopplung erzielt, wobei die letztere über drei Gegentaktstufen wirksam ist. Wo möglich, wird zwischen den Stufen direkte Kopplung benutzt, um Bauelemente zu sparen und die Betriebsbedingungen für die Transistoren zu stabilisieren. Die Stufen mit niedrigem Pegel werden entzerrt, so dass sich bei Benutzung des Verstärkers mit UKW-Vorsatzgerät ein flacher Frequenzgang ergibt.

Netzwerke für optimale Transistorstabilisierung von J. D. Meindl und O. Pitzalis

Zusammenfassung des Beitrages auf Seite 798-802

Eine umfassende Berechnungsmethode für Transistor-Gleichstromstabilisierungsnetzwerke wird beschrieben, in der die temperaturempfindlichen Parameter I_{CB0}, V_{BE} und h_{FE} voll berücksichtigt werden. Der Einfluss von Temperaturschwankungen auf den Widerstand und die Stromversorgung des Stabilisierungsnetzwerkes wird besprochen. Toleranzen der Transistor-Parameter und des Widerstandes werden ebenfalls in Betracht gezogen. Das Stabilisierungsnetzwerk ist für geringste Leistungszerstreuung ausgelegt.

Ein phasenempfindliches Nachweisgerät von G. Scantlebury

Zusammenfassung des Beitrages auf Seite 803-805

Dieser Beitrag beschreibt eine Form des phasenempfindlichen Nachweisgerätes, in dem das Bezugssignal und das variable Signal eine gemeinsame Klemme haben, die geerdet sein kann. Die Anzahl der benötigten Bauelemente ist gering, und es werden keine Spezialtransformatoren mit Mittelanzapfung benötigt. Das Gerät wurde ursprünglich für den Ausgangsnachweis einer Wechselstrombrücke entwickelt, es zeigte sich jedoch, dass es auch andere wertvolle Eigenschaften hat. Einige derselben werden im Beitrag beschrieben, und im Anhang wird eine volle Analyse des Allgemeinfalles gegeben.

Lumineszenzmessung von G. P. Burn

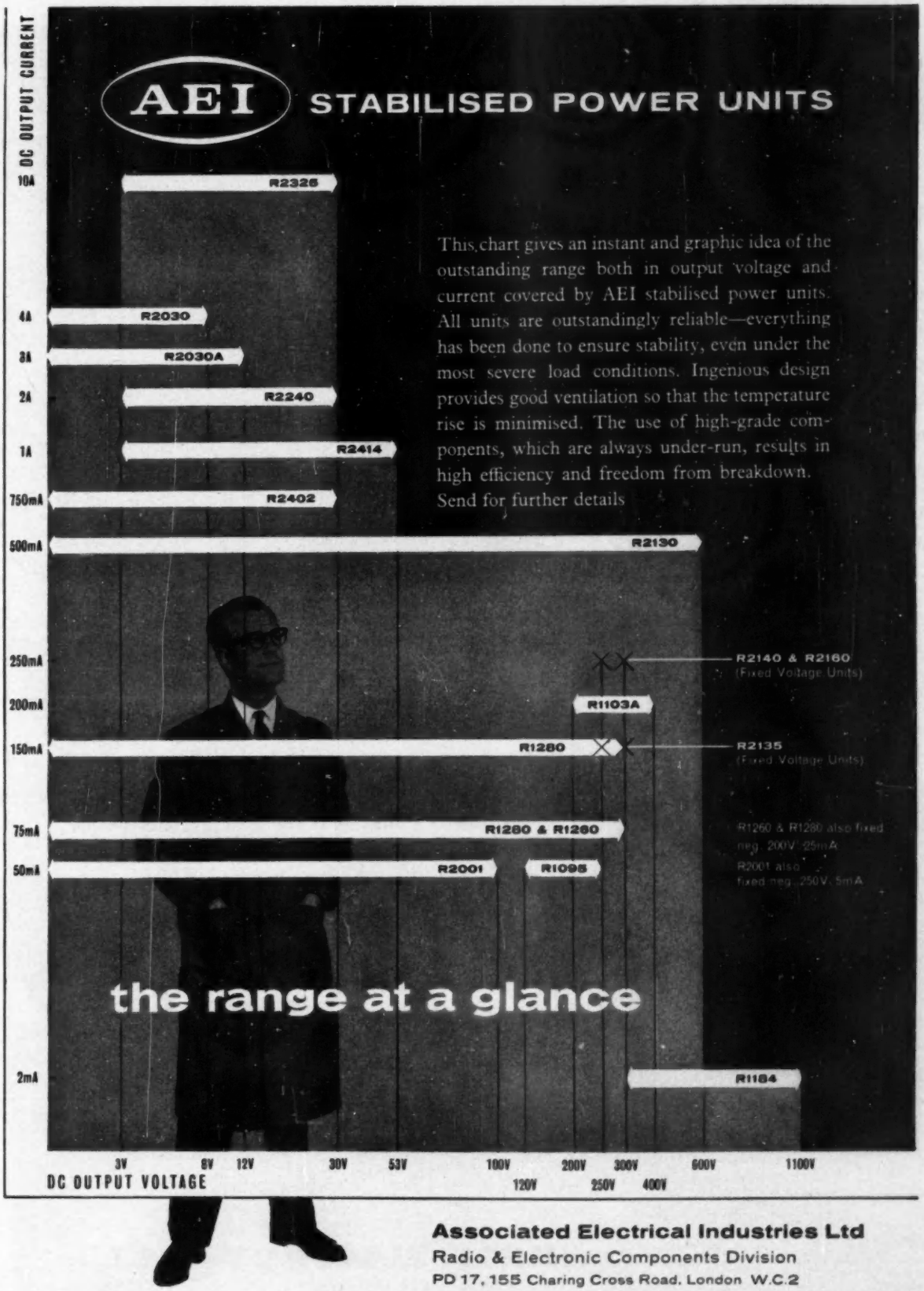
Zusammenfassung des Beitrages auf Seite 806-807

Dieser Beitrag beschreibt, wie sehr schwache Lumineszenz durch Zählen der Ausgangsimpulse eines Photovervielfachers gemessen werden kann. Das vollständige Gerät besteht aus dem Photovervielfacher, seiner Stromversorgung und einem Vorverstärker, dessen Ausgang in einen Standard-Impulshöhendiskriminator und -zähler gespeist wird.

Dünne Metallschichten in Millimeter-Wellen-Messungen von M. H. Cufflin

Zusammenfassung des Beitrages auf Seite 808-810

Im Rahmen eines Projektes für Millimeter-Wellen-Messungen mussten einige Kopplungs- und Reflektorscheiben für kreisrunde Hohlleiter entwickelt werden. In diesem Zusammenhang wurde die Verwendung von auf dünne Glasscheiben aufgedampften Metallschichten untersucht; die sich ergebenden Resultate für Metallschichten mit und ohne Schlitze werden in diesem Beitrag eingehend beschrieben.



Associated Electrical Industries Ltd
Radio & Electronic Components Division
PD 17, 155 Charing Cross Road, London W.C.2
Telephone: GERrard 9797 Telegrams: Sieswan Westcent London
TA17/103

EE 40 144 *for further details*

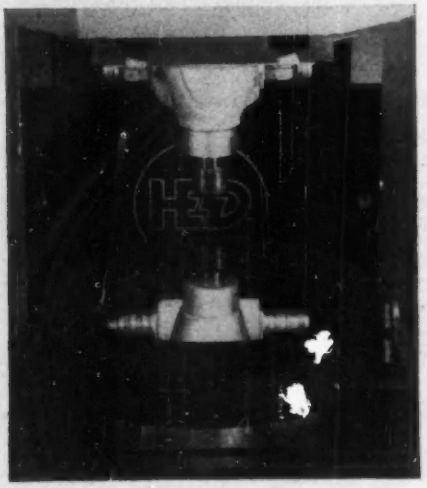
HED

introduce a further advance in the instrumentation of resistance welding . .

CYCLE COUNTER CURRENT METER

The HED Current Meter and the Cycle Counter are two first-class instruments in the range of HED instrumentation, and are designed to assist the Welding Engineer in the rapid and accurate setting up of machines and monitoring to ensure consistency of quality

A model combining the Resistance Welding Current Meter and Cycle Counter in one case, and utilising the same toroid or Search Coil, is now available. The Cycle Counter and the Current Meter are also available as separate instruments.



4½ in. interior diameter split toroid. This transformer can be clipped over any part of the welder secondary circuit and will monitor both time and current simultaneously. Can be clamped around any conductor for giving peak current readings.

FURTHER DETAILS AVAILABLE ON REQUEST

ILLUSTRATED ARE SOME TYPICAL CYCLE COUNTER AND CURRENT METER SEARCH COILS

Cycle Counter Search Coil S.C/2.

Toroid CMT/5. Designed for very low current welding. Has an X5 multiplying factor giving the Current Meter a full scale range of 500 amps. Bore of Toroid ½ in.

SC/1. A Search Coil and integrator to give visual indication of welding current on Oscilloscope.

HIRST ELECTRONIC LTD.

GATWICK ROAD · CRAWLEY · SUSSEX

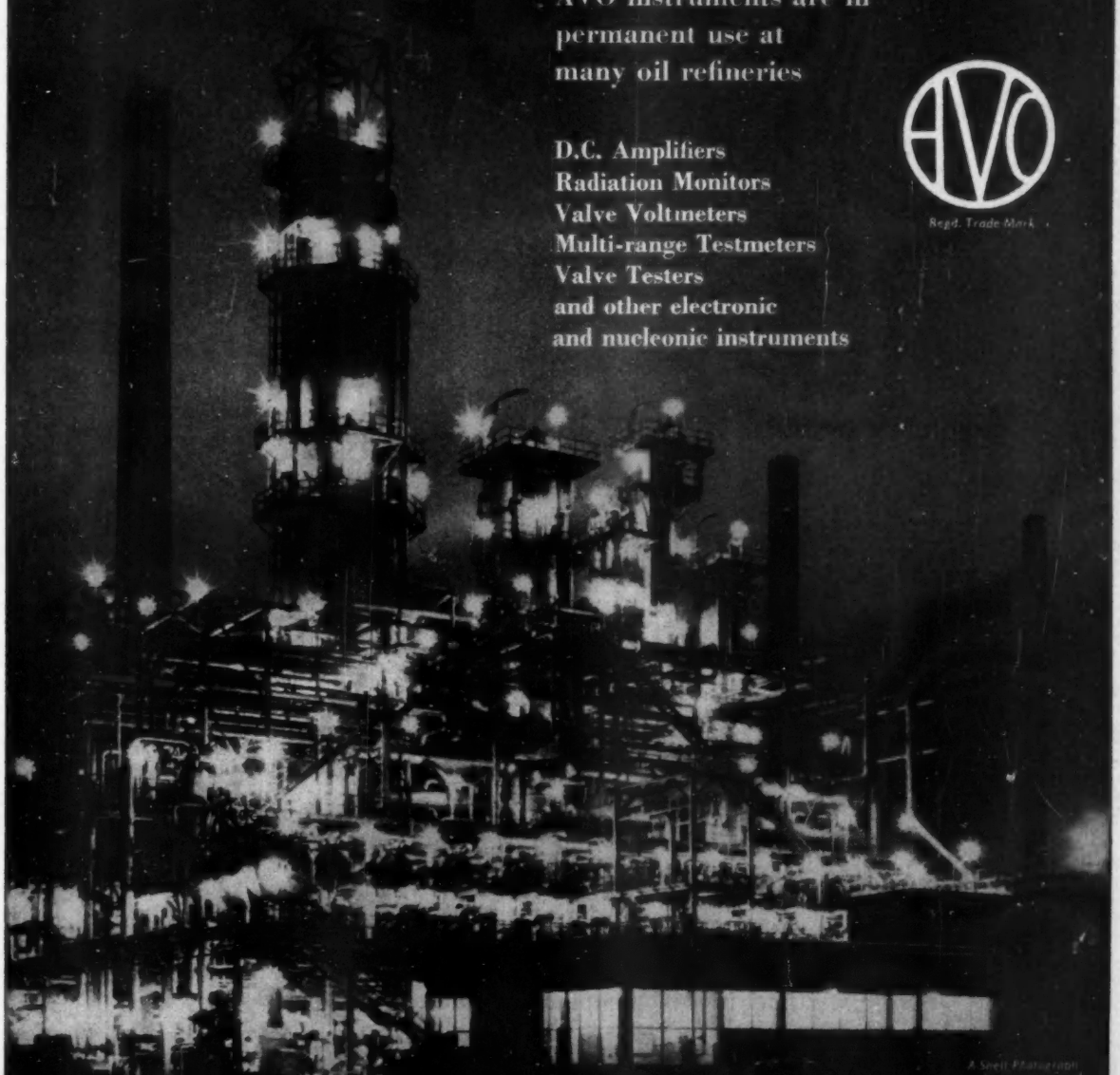
CRAwley 25721-2-3-4

AVO INSTRUMENTATION

AVO instruments are in permanent use at many oil refineries

D.C. Amplifiers
Radiation Monitors
Valve Voltmeters
Multi-range Testmeters
Valve Testers
and other electronic
and nucleonic instruments

AVO
Regd. Trade Mark



A Shell Photograph

AVO LTD AVOCET HOUSE · 92-96 VAUXHALL BRIDGE ROAD · LONDON S.W.1
Telephone: VICtoria 3404 (12 lines) Cables: Avocet, Sowest, London

G22

MEMBER OF THE METAL INDUSTRIES GROUP OF COMPANIES

EE 40 146 for further details

Out of print volumes of "Electronic Engineering"

are to be reprinted in full size

by

Wm. DAWSON & SONS LTD

The first volumes scheduled to be reprinted are volumes 13-26 covering the years 1940-1954. Further volumes are to be reprinted in due course.

Price per volume £6-10-0 bound

For further details write to:—

Wm. DAWSON & SONS Ltd.

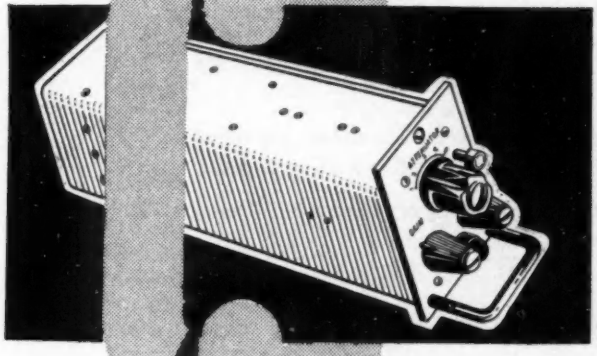
16, WEST STREET, FARNHAM, SURREY.

indicating in which volumes you are particularly interested or fill in the reference No. given above on one of the Reader Information Service Cards.

EE 40 147 *for further details*

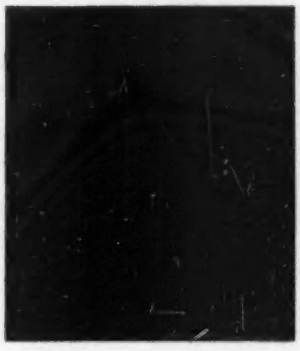
A·W·E

TRANSISTOR GALVANOMETER AMPLIFIER
COMPLETES THE SYSTEMS LINK



SEE THE STRAIN

AND MEASURE
IT TOO—
IF YOU'RE WISE



The measurement of strain is an increasingly important task in modern industrial planning and in a multitude of operations. One major problem is the amplification of strain gauge signals and the A.W.E. Transistor Galvanometer Amplifier is ideally suited for this purpose. □ The T. G. A. is one unit of a specially developed recording system which has a wide application in strain gauge pressure measurement and the general instrumentation field. □ The Amplifier is a modular unit, designed to drive viscously damped galvanometers which normally have a resistance of 50 ohms and a working range of DC to 2 Kc/s in Frequency. □ *Do your strain gauge problems include measurements up to 1,000°-C? We can supply 'Avro' strain gauges to meet these stringent requirements:—Write to us for details.*

DRIFT 2mA/°C at output into 50Ω load at max. gain
GAIN 7·5mA/mV. Maximum into 50Ω load
OUTPUT ±35A. Max into 50Ω
SUPPLY ± 6 Volt. D.C. at 220mA each line

ARMSTRONG WHITWORTH EQUIPMENT, *HUCCLECOTE, GLOUCESTER. TELEPHONE: 66781*
WHITWORTH GLOSTER AIRCRAFT LTD., COVENTRY, ENGLAND. MEMBER OF HAWKER SIDDELEY AVIATION

EE 40 148 *for further details*

SIMA

a unique source of INFORMATION on scientific instruments

There are two kinds of knowledge; knowing and 'knowing where to find out'. With science and technology developing so rapidly no one can hope to be fully informed on every worthwhile new technique or new equipment.

Here are three ways in which 'knowing where to find out' can help you:

(1) If you already know the answer to your problem but don't know who makes the most suitable equipment SIMA can tell you.

(2) If the answer to your problem depends on whether someone has already developed suitable equipment, SIMA will know if it exists and can tell you where to get it.

(3) If you just have a problem, SIMA can often tell you whether someone has already found the answer to it and has developed equipment to meet it.

Where do SIMA get their information?

From two sources. One is the British Scientific Instrument Research Association (BSIRA) which maintains a comprehensive library of catalogues. The other is the membership, consisting of over 180 companies engaged in all these fields of instrumentation.

OPTICAL & OPHTHALMIC	LABORATORY & ANALYTICAL
ELECTRONIC & NUCLEONIC	MEDICAL & X-RAY
ENGINEERING & INDUSTRIAL	KINEMATOGRAPHIC
NAVIGATIONAL & SURVEY	PROCESS CONTROL & AUTOMATION

The Scientific Instrument Manufacturers' Association could be your most valuable source of such information and you will find them very helpful on *any* question about scientific instruments.

the SIMA enquiry service

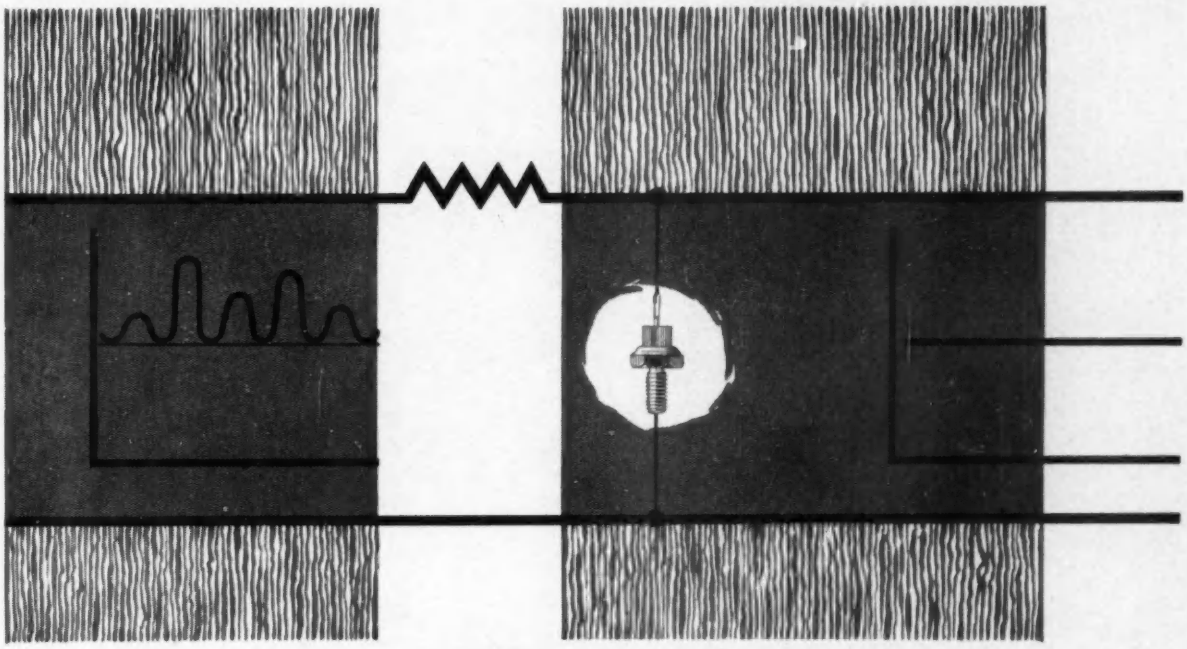
Over 180 manufacturers with one address

SCIENTIFIC INSTRUMENT MANUFACTURERS' ASSOCIATION OF GREAT BRITAIN

20, QUEEN ANNE STREET, LONDON, W.1.

Telephones—Secretariat Langham 4251 Enquiry Service Imperial 6000

Space donated by member : MICROCELL ELECTRONICS, Station Estate, Blackwater, North Camberley, Surrey



....only LUCAS silicon voltage regulators have all these features

Available in anode to stud, cathode to stud, or double anode versions. Single anode devices may also be used as low voltage rectifiers, having normal rectifier forward characteristics. High power-handling capacity.

Available in higher voltage ranges—up to 100 volts (single anode devices only). Good delivery. Competitive prices. Sales Engineers covering the country and an Applications Team available to advise on all customers' problems.

Type ★	Nominal Zener Voltage	Power Dissipation Watts
ZD 508 CD 58	8.2	10
ZD 510 CD510	10	10
ZD 512 CD 512	12	10
ZD 518 CD 518	18	10
ZD 522 CD 522	22	10
ZD 527 CD 527	27	10
ZD 533 CD 533	33	10

★ ZD indicates Zener
CD indicates Clipper

The Lucas range of Silicon voltage regulators, covers the voltage range between 8.2 and 33 volts. The regulators are available either as Zener Diodes for D.C. voltage regulation, or as Clipper Diodes for A.C. amplitude control.

FEATURES

- ★ Hermetically sealed
- ★ Operating ambient temperature, —55C to +150C
- ★ Zener voltage tolerance ±10%
- ★ Stud mounted
- ★ Small physical size

MANUFACTURE & RESEARCH

Joseph Lucas Ltd

Sales & Technical Applications

G & E Bradley Ltd

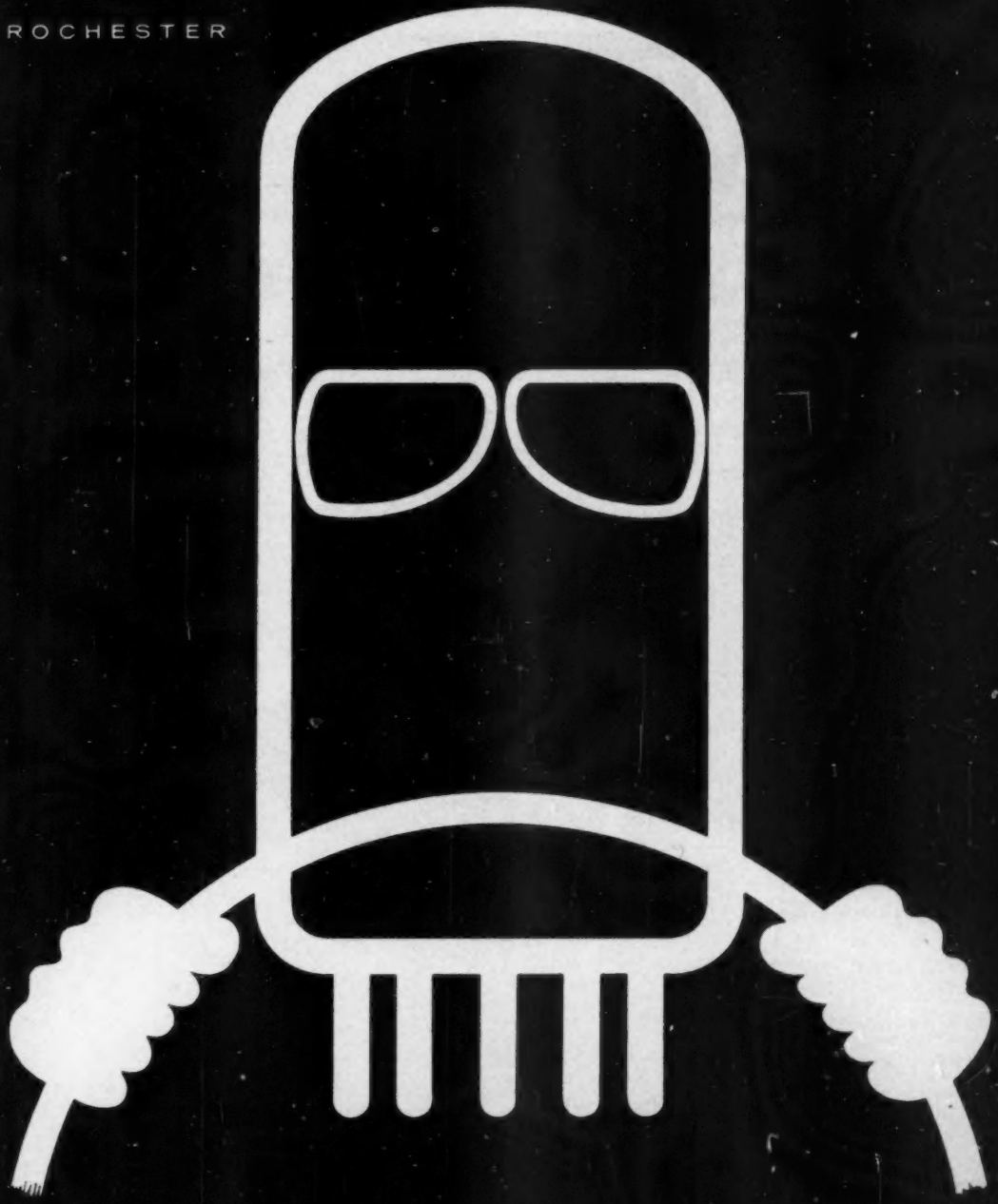
ELECTRAL HOUSE, NEASDEN LANE, LONDON N.W.10
Telephone: Dollis Hill 7811

A Subsidiary Company of Joseph Lucas (Industries) Ltd.

EE 40 150 *for further details*

COOLING
FOR ALL
COMPONENTS
In electronic engineering *precise* temperature control is essential for the speedy and accurate measurement and analysis of data. This particularly applies in the field of all-transistorised electronic assemblies where the generated heat must be controlled to ensure absolute accuracy and efficiency of the equipment in use. This is where STERNE'S knowledge of refrigeration is invaluable; by the application of their wide experience they can provide the solution to many complex problems.
STERNE
REFRIGERATION
FOR ALL ASPECTS OF REFRIGERATION
L. STERNE & COMPANY LTD. The Crown Iron Works, GLASGOW.
Tel.: DOUglas 6461 (10 lines).
Full Technical and service facilities available at the following branches:
LONDON · LIVERPOOL · ABERDEEN · BRISTOL · BELFAST · CARDIFF · DERBY · HULL · NEWCASTLE · LEEDS

ROCHESTER



Both you and the racing driver have agreed throughout the year that all circuits have their own characteristics and problems but you, when selecting valves for all round optimum performance, will go on saying . . . . . better make them BRIMAR

Brimar Commercial Division

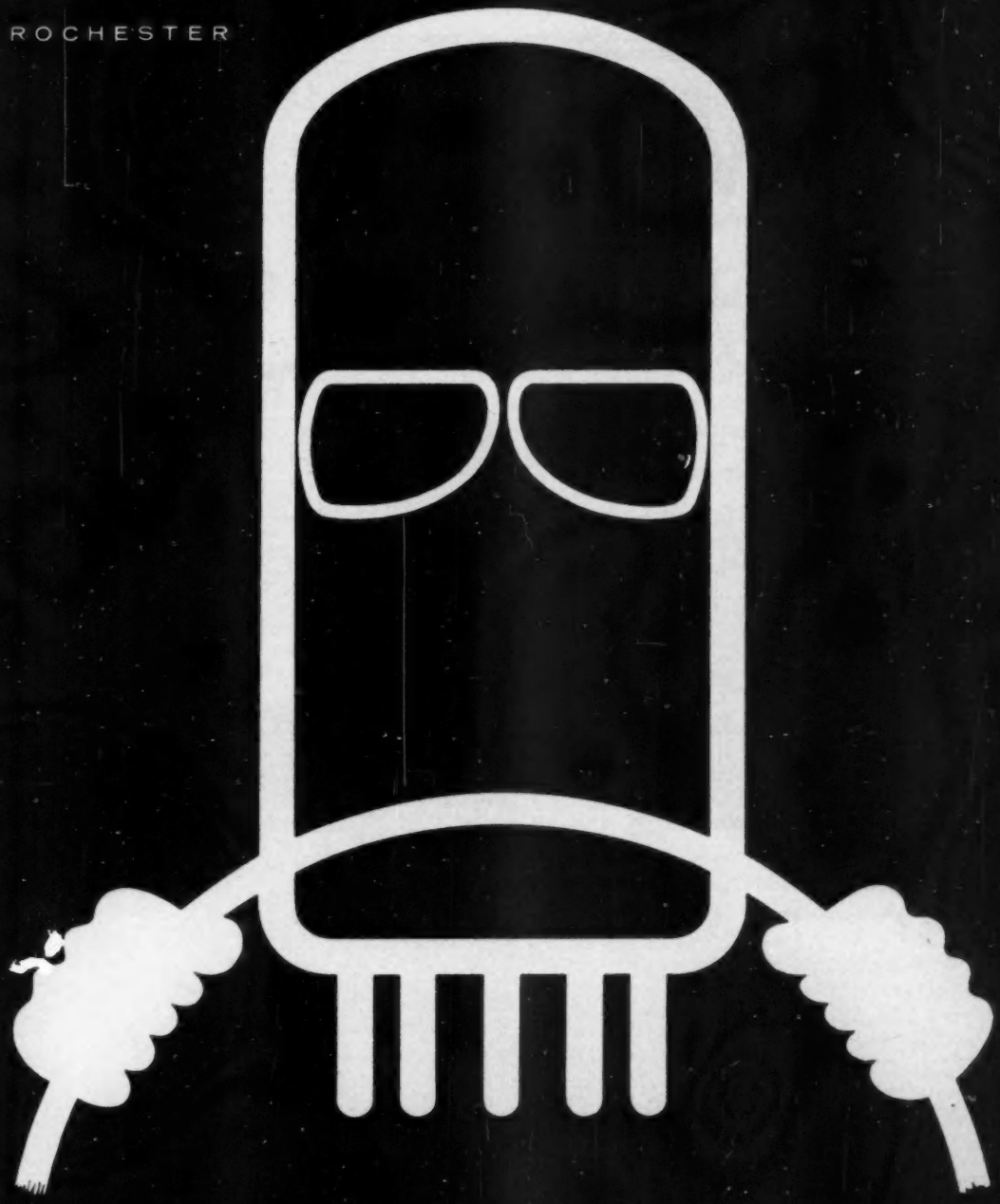
THORN-AEI RADIO VALVES & TUBES LTD. ROCHESTER, KENT. CHATHAM 44411

BVA

EE 40 150 *for further details*

COOLING
FOR ALL
COMPONENTS
In electronic engineering *precise* temperature control is essential for the speedy and accurate measurement and analysis of data. This particularly applies in the field of all-transistorised electronic assemblies where the generated heat must be controlled to ensure absolute accuracy and efficiency of the equipment in use. This is where STERNE'S knowledge of refrigeration is invaluable; by the application of their wide experience they can provide the solution to many complex problems.
STERNE
REFRIGERATION
FOR ALL ASPECTS OF REFRIGERATION
L. STERNE & COMPANY LTD. The Crown Iron Works, GLASGOW.
Tel.: DOUglas 6461 (10 lines).
Full Technical and service facilities available at the following branches:
LONDON · LIVERPOOL · ABERDEEN · BRISTOL · BELFAST · CARDIFF · DERBY · HULL · NEWCASTLE · LEEDS

ROCHESTER



Both you and the racing driver have agreed throughout the year that all circuits have their own characteristics and problems . . but you, when selecting valves for all round optimum performance, will go on saying . . . . . better make them BRIMAR

Brimar Commercial Division

THORN-AEI RADIO VALVES & TUBES LTD. ROCHESTER, KENT. CHATHAM 44411

BVA

EE 40 152 *for further details*

DAWE

TRANSISTOR PHASE METER

TYPE 630

. . . designed for measuring phase difference between two signal sources in the range 1c/s to 10kc/s.

- ★ **All transistor operation**
- ★ **Direct reading**
- ★ **Wide variations of signal amplitude permissible**
- ★ **High input impedance**
- ★ **High sensitivity**
- ★ **Self contained batteries and mains power unit**
- ★ **No warm up period required**
- ★ **Extremely compact and portable**
- ★ **Very low power consumption**

APPLICATION:

The Type 630 Transistor Phase Meter is an instrument designed to measure the difference in phase angle between two signals in the audio or sub-audio frequency range. It combines simplicity, low cost and adequate accuracy for almost all applications. Measurement of phase shift through networks, tuned circuits and servo systems may be readily made with negligible loading on the equipment under test. The instrument is particularly suitable for vibration and resonance testing and with appropriate pick-ups, measurement of torsional strain in rotating shafts can be made.

A simple phase meter such as the Type 630 is a valuable aid for the practical demonstration of circuit theory, feed-back, mechanical and electrical resonance and similar problems in Universities and Technical Colleges.

OPERATION:

To prevent difficulty of interpretation when the signals are almost in phase, a 180° phase shift circuit may be selected and the 180°-0°-180° scale used.

The instrument uses readily obtainable torch batteries with a typical life of 40 hours at 8 hours per day. Alternatively operation from the normal a.c. mains supply is provided by the internal power unit.

Other fully-transistorised laboratory instruments include—A.C. Milliclamp Type 618, Vibration Meter Type 1451, Transistor Radio Oscillator Type 421 Frequency Meter Type 715

Phase Angle Ranges:
0°—360° or 180°—0°—180°

Frequency Range:
1 c/s to 25 kc/s

Input Voltage and Impedance:
30 V to 300 V r.m.s. into 10MΩ
3 V to 30 V r.m.s. into 1MΩ
0.3 V to 3 V r.m.s. into 100kΩ
0.03 V to 0.3 V r.m.s. into 10kΩ

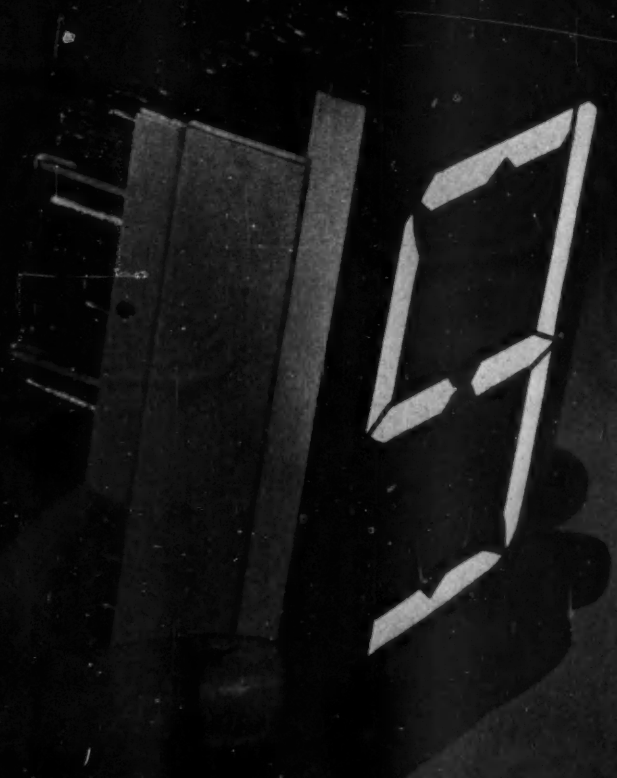
Phase Accuracy:
With Balanced Signals 0°—360° range:
10 c/s to 10 kc/s ±3°
1 c/s to 10 c/s ±5°
180°—0°—180° range:
10 c/s to 10 kc/s ±5°
10 kc/s to 25 kc/s—typically ±5°
up to ±10° phase difference.
With Unbalanced Signals typical error ±10° for 3:1 or 1:3 unbalance from 10 c/s to 1 kc/s.

Power Supply:
100—125 V and 200—250 V a.c. or self-contained batteries (eight Ever-Ready Type U11 or equivalent).

Technical data forwarded on request: DAWE INSTRUMENTS, LTD. WESTERN AVENUE, ACTON, LONDON, W.3. Tel: ACOrn 6751

A MEMBER OF THE Simms GROUP OF COMPANIES

A combination of the Phosphotron electroluminescent numerical indicator and Ericsson long-life card-lift miniature relays makes available for the first time a compact modular unit providing a 4″ readout and a complete miniature counter within an overall depth of only 2⅝″. The Phosphotron operates direct from the mains or suitable inverter while the counter operates from 12V d.c. which can be common to the inverter supply. Pulses are obtained from any elementary pair of make contacts. For multiple readout, units are mounted immediately adjacent to each other with electrical connection made by simple strapping. Relating size of readout to component volume, this advanced packaged unit Type LJEQ11/40 is the most economical at present available.



More information will gladly be sent on request to—
Technical Services Department,
Physics Division,
Ericsson Telephones Ltd.,
Beeston, Nottingham.

* *Phosphotron is an Ericsson Registered Trademark*

ERICSSON

ERICSSON TELEPHONES LIMITED HEAD OFFICE 22 LINCOLN'S INN FIELDS LONDON WC2 TEL HOLBORN 6936

ER.54

EE 40 154 *for further details*

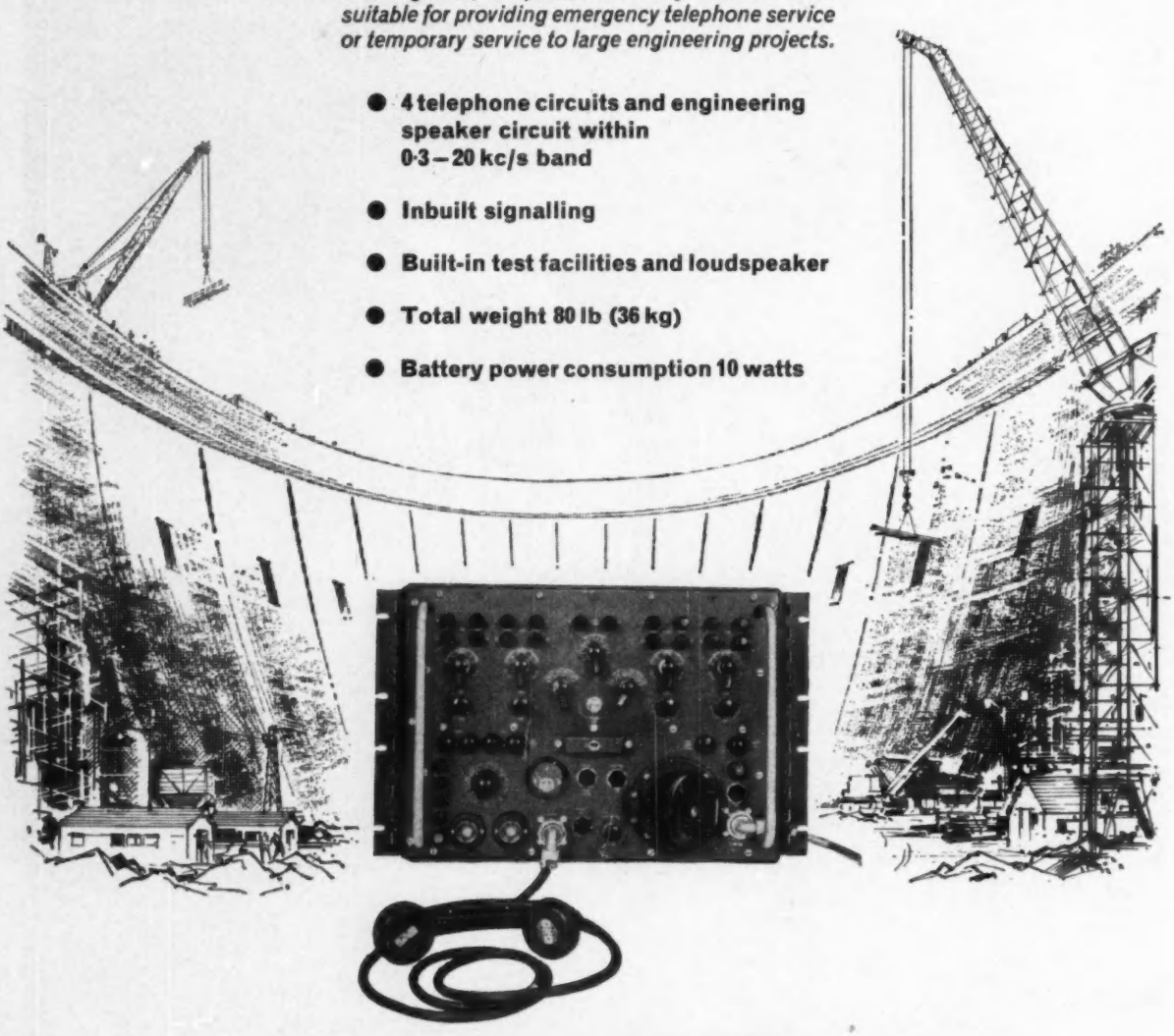
STC

all-transistor 4-circuit telephone channelling

a compact self-contained channelling equipment
for use with VHF or SHF radio links or cables

This robust equipment, housed in a waterproof box, is designed for operation in any climate. It is suitable for providing emergency telephone service or temporary service to large engineering projects.

- **4 telephone circuits and engineering speaker circuit within 0·3—20 kc/s band**
- **Inbuilt signalling**
- **Built-in test facilities and loudspeaker**
- **Total weight 80 lb (36 kg)**
- **Battery power consumption 10 watts**



61/9C

Standard Telephones and Cables Limited

TRANSMISSION SYSTEMS DIVISION • NORTH WOOLWICH • LONDON E.16

AEI focus on...

SEMICONDUCTOR DEVICES

The rapidly increasing range of semiconductor devices developed and produced by AEI includes:

DIODES—Capable of operating at **up to 12,000 Megacycles.**

HEAVY-CURRENT POWER RECTIFIERS —AEI have already supplied equipments totalling **over half a million Kilowatts.**

and ▪ Tunnel diodes ▪ Microwave diodes ▪ Silicon and Germanium diodes ▪ Silicon and Germanium transistors Silicon and Germanium Power Rectifiers ▪ Silicon controlled Rectifiers

Please address enquiries to *your nearest AEI District Office* or to:

AEI

Associated Electrical Industries Limited

Heavy Plant Division
RUGBY

Electronics Apparatus Division
LINCOLN

A5711

EE 40 156 *for further details*

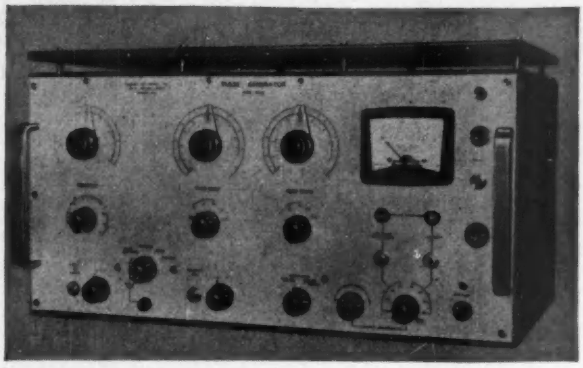
KASAMA Laboratory Equipment

PULSE AND SQUARE WAVE GENERATOR TYPE 302A

½ AMP peak output pulse
.015 μS rise time
0-100 V. positive or negative pulse

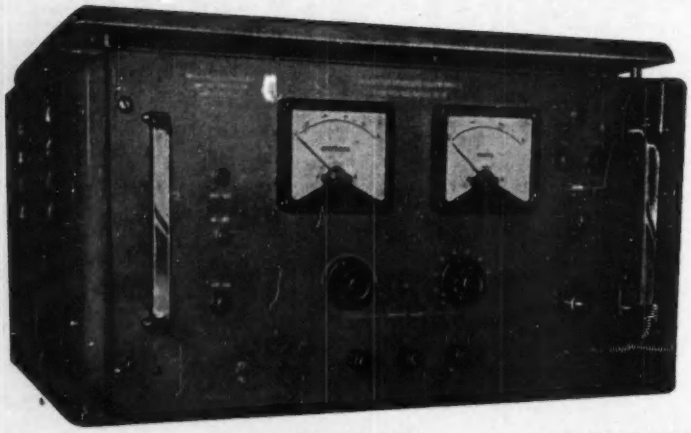
P.R.F. generator	**10 c/s to 1Mc/s**
Delay	**0.3 μS to 10MS**
Pulse width	**0.2 μS to 10MS**
Square waves	**10 c/s to 1Mc/s**

DOUBLE PULSE GENERATOR ALSO AVAILABLE



• • • • • • • • • •

HIGH CURRENT TRANSISTOR POWER SUPPLIES



Model KTV/310

Model	Output current amperes
KTV/310	**10**
KTV/320	**20**
KTV/330	**30**
KTV/340	**40**
KTV/350	**50**

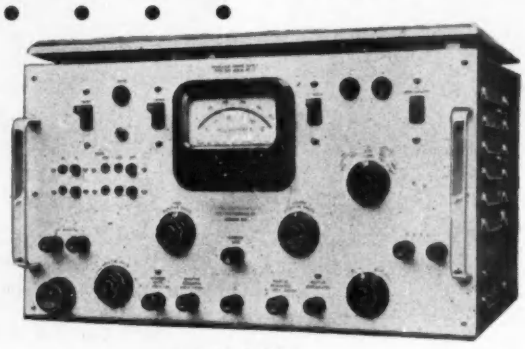
Voltage range: 0-30 V.D.C.
Stabilisation: 1,000 : 1
Ripple: 1MV
Internal resistance: .003 ohm
Overload cut-out
Positive or negative output

OTHER TRANSISTOR POWER SUPPLIES AVAILABLE

• • • • • • • • • •

WIDE RANGE STABILISED POWER SUPPLY

±0 to 750 V.D.C. Voltage range
or ±0-500V and ±250V
250 mA output current
Voltage stabilisation: 1,000 : 1
Ripple: 1mV
Internal resistance: 0.02 ohm
Two Heaters 6·3 volts 5 amps each
Positive or negative output



Model 214

ALSO AVAILABLE—OSCILLOSCOPES, TRANSISTOR ANALYSER, HIGH VOLTAGE POWER SUPPLIES

For full information and descriptive literature on other LABORATORY TESTING EQUIPMENT *call, write or phone*

KASAMA ELECTRONICS LTD

139-149 FONTHILL ROAD, FINSBURY PARK, LONDON, N.4

Telephone: ARChway 6160

EE 40 157 *for further details*

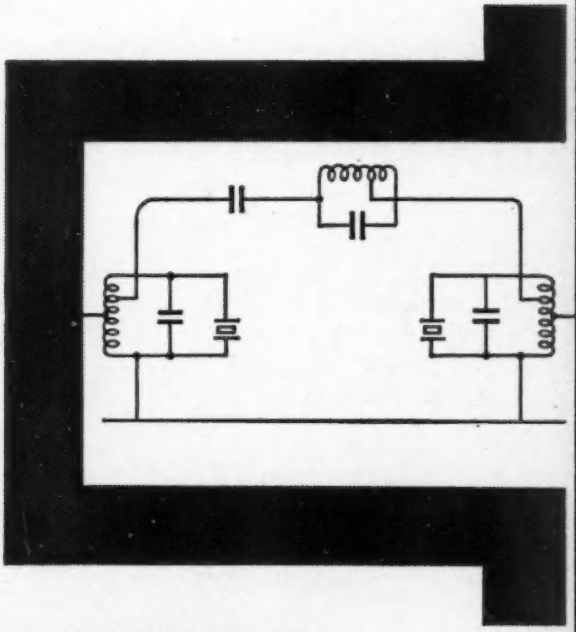
NEW FILTER SERVICE SPEEDS PRODUCTION

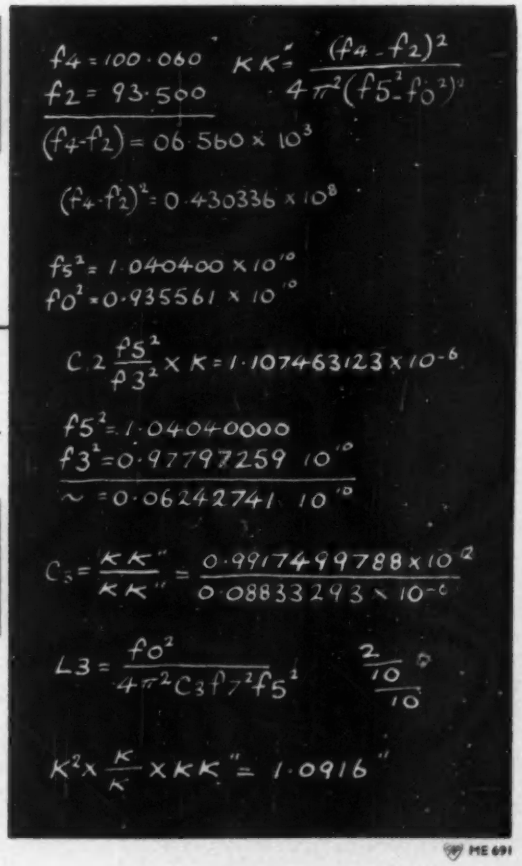
The design of filter networks, though obviously an integral and important part of a complete equipment, can be excessively time-consuming—especially if the filter required is non-standard.

Now, to save your time and to release development engineers for other work, Mullard Equipment Limited offer a complete filter service backed by a full-time team of Filter Engineers.

This service includes the basic design, development, testing and manufacture—producing quickly and economically exactly the filter performance you require.

To learn more about this time-saving service, write quoting reference D/691/12.





MULLARD EQUIPMENT LIMITED

MANOR ROYAL · CRAWLEY · SUSSEX
Telephone: Crawley 28787

ME 691

Presswork and Springs of every type

IN ALL METALS TO THE FINEST LIMITS
SPECIALISTS IN BERYLLIUM COPPER
PROGRESSIVE PRESS TOOLS
MULTI SLIDE AND TRANSFER PRESSES
HIGH PRODUCTION DEEP DRAWING

Electro (Spark) Erosion for the Trade

Helical Tension, Torsion and Compression Springs and Wire Shapes from 40 S.W.G. (0·0048in.) to $\frac{1}{16}$ in. dia. Wire

FULLY A.I.D. AND A.R.B. APPROVED

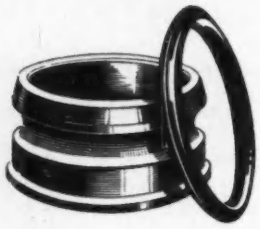
SPRING STEEL PRODUCTIONS LTD

FACTORIES:—
HEAD OFFICE:—COMMERCE ESTATE, RAVEN ROAD, SOUTH WOODFORD, E.18. BUC. 9601/3.
784-788 HIGH ROAD, TOTTENHAM
LONDON, N.17 . TEL.: TOTTENHAM 7745/7

another new development by Insuloid

The famous Ring Lock Bush

—now in NYLON

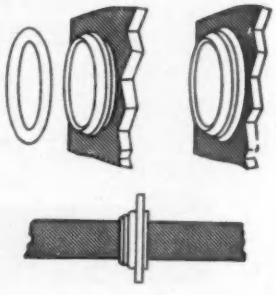


In addition to the standard Silica-loaded Ebonite Components—proved over many years Insuloid Ring Lock Bushes are now available *in unbreakable NYLON at NO EXTRA COST.*

Specially designed for instant assembly the bush is fixed by simple snap-on finger action . . . yet once fixed it can only be removed by special tools. Insuloid Ring Lock Bushes give maximum protection at the point where cables pass through partitions etc. and completely exclude the possibility of damage due to bushings becoming dislodged. *The Bush that WON'T come out.*

- ★ **Installed without tools—takes only seconds to fix.**
- ★ **Secure against vibration, cannot work loose.**
- ★ **Proper fitting can be seen at a glance.**
- ★ **No tapping or countersinking of hole is required.**
- ★ **Simple, inexpensive, efficient.**
- ★ **Impervious to water, oil, acids, or any climatic conditions.**

Insuloid Ring Lock Bushes consist of two components only:—
1. The shaped plastic sleeve.
2. The elastic locking ring.
These components are impervious to water, oil, petrol, acids or any climatic condition. The bush is effective over a temperature range of —40°C to +100°C. Approved for service use by Air Ministry, Ministry of Supply, Admiralty and G.P.O.

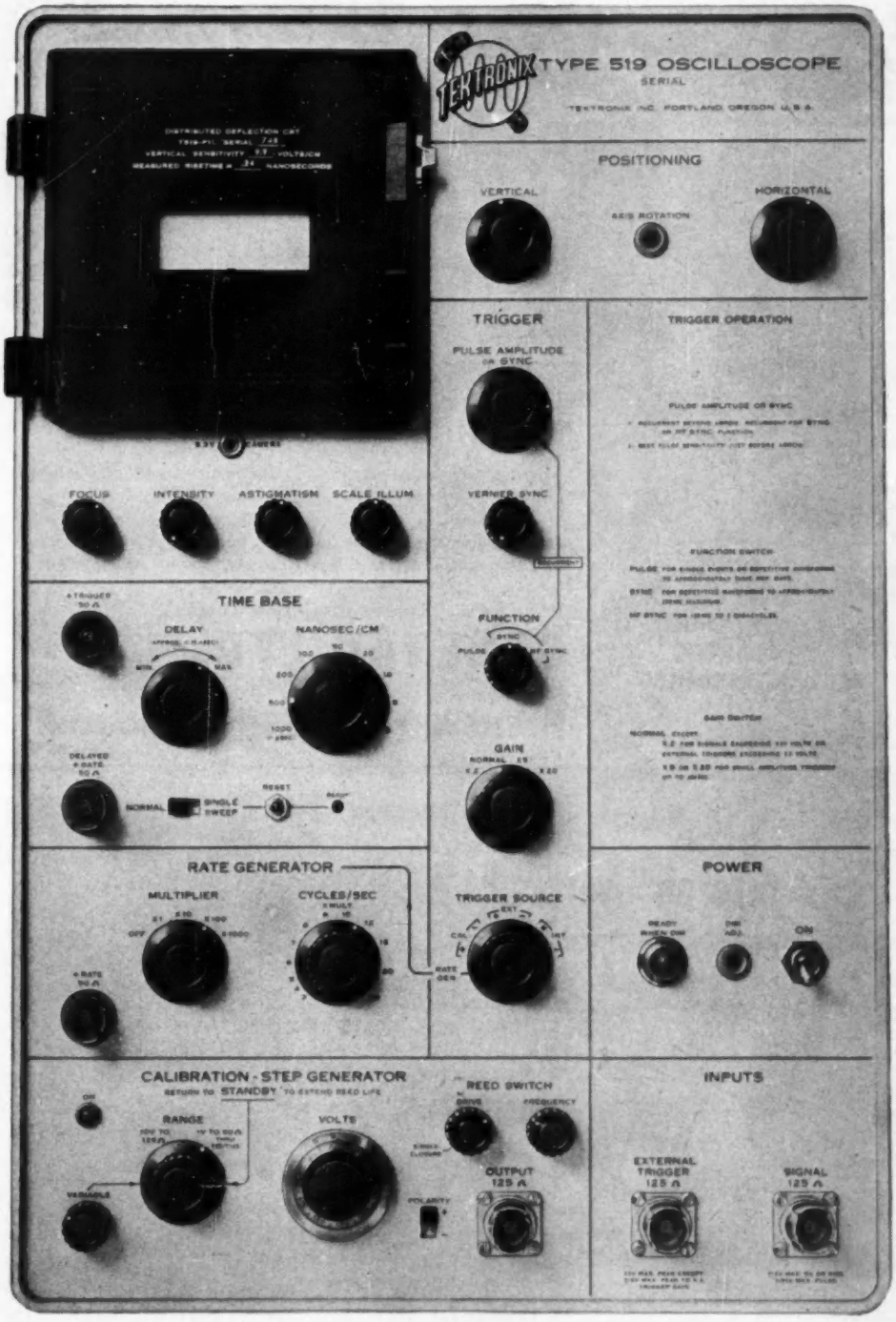


Available in a range of sizes to accommodate cables from $\frac{1}{16}$" up to 2" diameter.

Write now for fully illustrated literature to:—

INSULOID MANUFACTURING CO. LTD.
Sharston Works, Leestone Road, Wythenshawe, Manchester.
Tel: Wythenshawe 2842 & 3163.

NRBI



TEKTRONIX 519 OSCILLOSCOPE

519

TEKTRONIX

519

oscilloscope

The bright trace and 2nsec/cm sweep speed of the Tektronix 519 Oscilloscope make possible photography of single transients with risetimes in the region of a quarter of a nanosecond.

Full details from sole U.K. representatives

LIVINGSTON LABORATORIES LTD

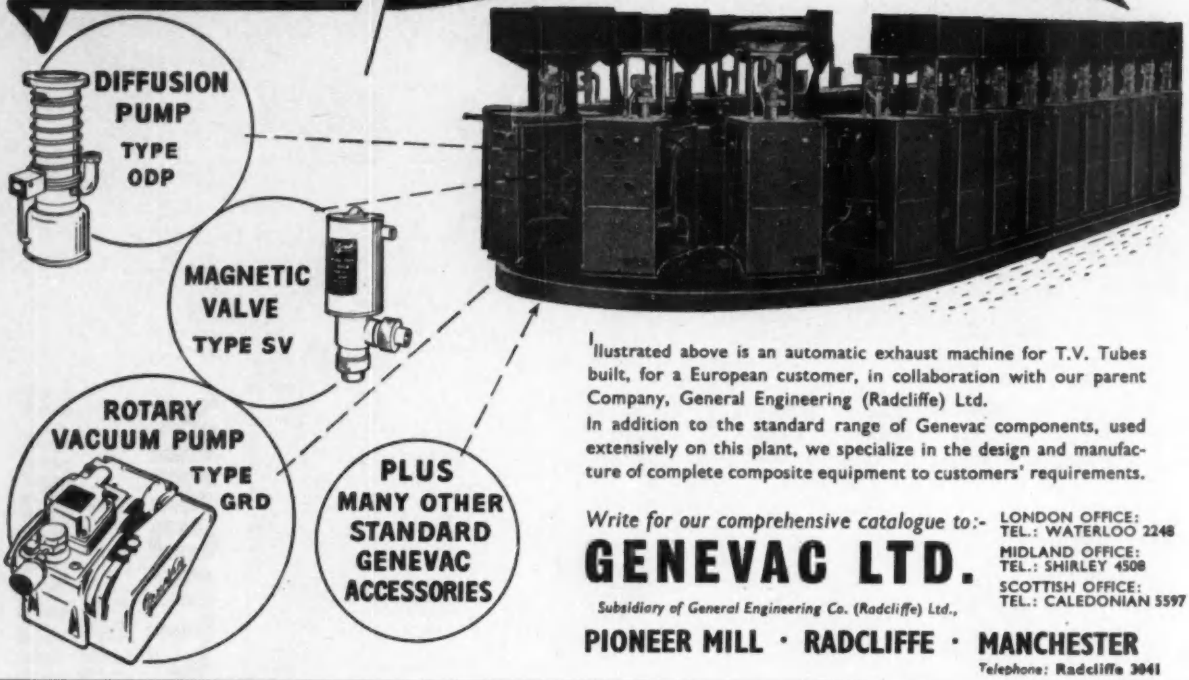
31 CAMDEN ROAD · LONDON · N·W·1

TELEPHONE: GULliver 8501 (10 lines)

Telex 21830

EE 40 161 *for further details*

GeneVac FOR HIGH VAC


DIFFUSION PUMP TYPE ODP
MAGNETIC VALVE TYPE SV
ROTARY VACUUM PUMP TYPE GRD
PLUS MANY OTHER STANDARD GENEVAC ACCESSORIES

Illustrated above is an automatic exhaust machine for T.V. Tubes built, for a European customer, in collaboration with our parent Company, General Engineering (Radcliffe) Ltd.

In addition to the standard range of Genevac components, used extensively on this plant, we specialize in the design and manufacture of complete composite equipment to customers' requirements.

Write for our comprehensive catalogue to:-

GENEVAC LTD.

Subsidiary of General Engineering Co. (Radcliffe) Ltd.,

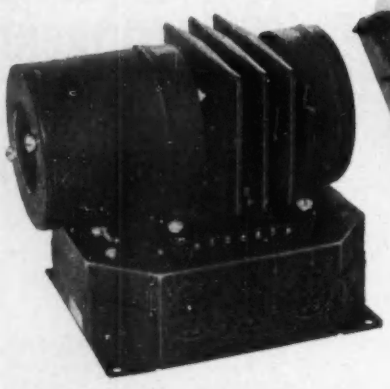
PIONEER MILL · RADCLIFFE · MANCHESTER

LONDON OFFICE: TEL.: WATERLOO 2248
MIDLAND OFFICE: TEL.: SHIRLEY 4508
SCOTTISH OFFICE: TEL.: CALEDONIAN 5597

Telephone: Radcliffe 3041

When does NRD "take off" vertically?

. . . when the Westland Wessex I rises from the ground.



Newton Derby Voltage Regulators are a vital part of the electrical system in this turbine-driven machine which is in quantity production for the Royal Navy and which is fitted with automatic equipment to allow operation by day and by night, in all weathers, from ship or from shore.

- **Motor Generator Sets**
- **Permanent Magnet Alternators**
- **Transistor Convertors**
- **High Frequency Alternators (400 to 3,000 c.p.s.)**
- **Automatic Voltage Regulators**
- **Servo Motors**
- **Rotary Transformers and Convertors**

NEWTON DERBY

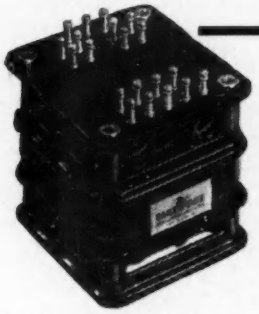
NEWTON BROS. (DERBY) LIMITED

ALFRETON ROAD, DERBY

Telephone: Derby 47676 (4 lines). *Grams:* DYNAMO DERBY
London Office: IMPERIAL BUILDINGS, 56 KINGSWAY, W.C.2

EE 40 162 *for further details*

Nine
out of every ten S·I·M·A members use Partridge Transformers!



Type Approval Certificate No. 1295 for hermetically sealed C-core range.

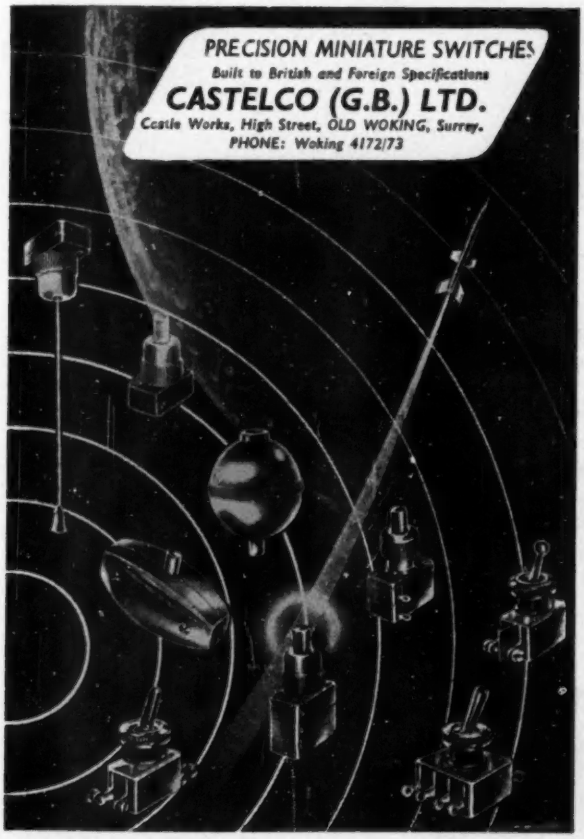
The high reputation enjoyed by Partridge Transformers for more than thirty years may be gauged from the many diverse applications in which they are employed on a world-wide scale—ranging, for example, from high-speed aircraft to radio telescopes. 95% of the instrument manufacturers in SIMA use Partridge Transformers in their products, just as many other manufacturers in the radio and electronic fields consistently use and specify Partridge.

The reliability of the Partridge Transformer is universally accepted and is a quality of value to you in your production. Consult us for your next application. We specialise in the speedy production of prototypes.

Partridge

Transformers for Electronics

Partridge Transformers Ltd.
Roebuck Road, Chessington, Surrey


PRECISION MINIATURE SWITCHES
Built to British and Foreign Specifications
CASTELCO (G.B.) LTD.
Castle Works, High Street, OLD WOKING, Surrey.
PHONE: Woking 4172/73

Wherever a conductive coating is indicated —

Wherever you need an electrically conductive coating, use one of the Foliac Colloidal Graphite Dispersions, or one of the new metallic dispersions of silver and copper powders developed specially for applications where maximum electrical conductivity is required. From C.R. tubes and thermionic valves to simple resistor contacts . . . name the use of a conductive coating and the answer is 'Foliac'. If you have a problem involving a conductive film, remember Foliac research is at your service. Why not ask our representative to call or write for further details?

FOLIAC

COLLOIDAL GRAPHITE DISPERSIONS

GRAPHITE PRODUCTS LIMITED
A Member of The Morgan Crucible Group

POINT PLEASANT · WANDSWORTH · LONDON S.W.18
TELEPHONE: VANdyke 6422

GP109/F/858

EE 40 166 *for further details*

HIGH RESOLUTION RECORDS ON WOODHILL'S

MINIATURE GALVANOMETER RECORDERS

Type 9 35mm.	Type 15 60mm.	Type 18 70mm.
9 CHANNEL	15 CHANNEL	18 CHANNEL

THESE HIGHLY DEVELOPED OSCILLOGRAPH FILM AND PAPER TRACE RECORDERS WILL MEET THE MOST EXACTING DEMANDS OF THE MODERN RESEARCH TECHNICIAN.

DESIGNED FOR HIGH RESOLUTION, UNIQUE IN SIZE, DEPENDABLE AND CONVENIENT IN USE, THEY ARE INDISPENSABLE FOR THE MOST DIFFICULT RECORDING PROBLEMS WHERE HIGH EFFICIENCY INSTRUMENTS ARE A *SINE QUA NON*.

DESIGN. WE DESIGN AND MANUFACTURE RECORDING INSTRUMENTS AND ALLIED EQUIPMENT TO CUSTOMERS' SPECIFICATIONS.

WOODHILL ENGINEERING CO. LTD.

TROUT ROAD, YIEWSLEY, MIDDLESEX Telephone: WEST DRAYTON 2892 & 3168

more tubing in production

VITREOSIL* pure fused quartz

New production techniques are now speeding up deliveries of Vitreosil Fused Quartz Tubing—the most transparent manufactured material.

It is impermeable, can be used repeatedly up to 1050°C, is inert to all acids except hydrofluoric, and has high light transmittance in the U.V. and I.R. spectra.

There are a wide range of diameters and two wall thicknesses—thin and normal.

Full details on request.

all BRITISH

T S L

...the BEST

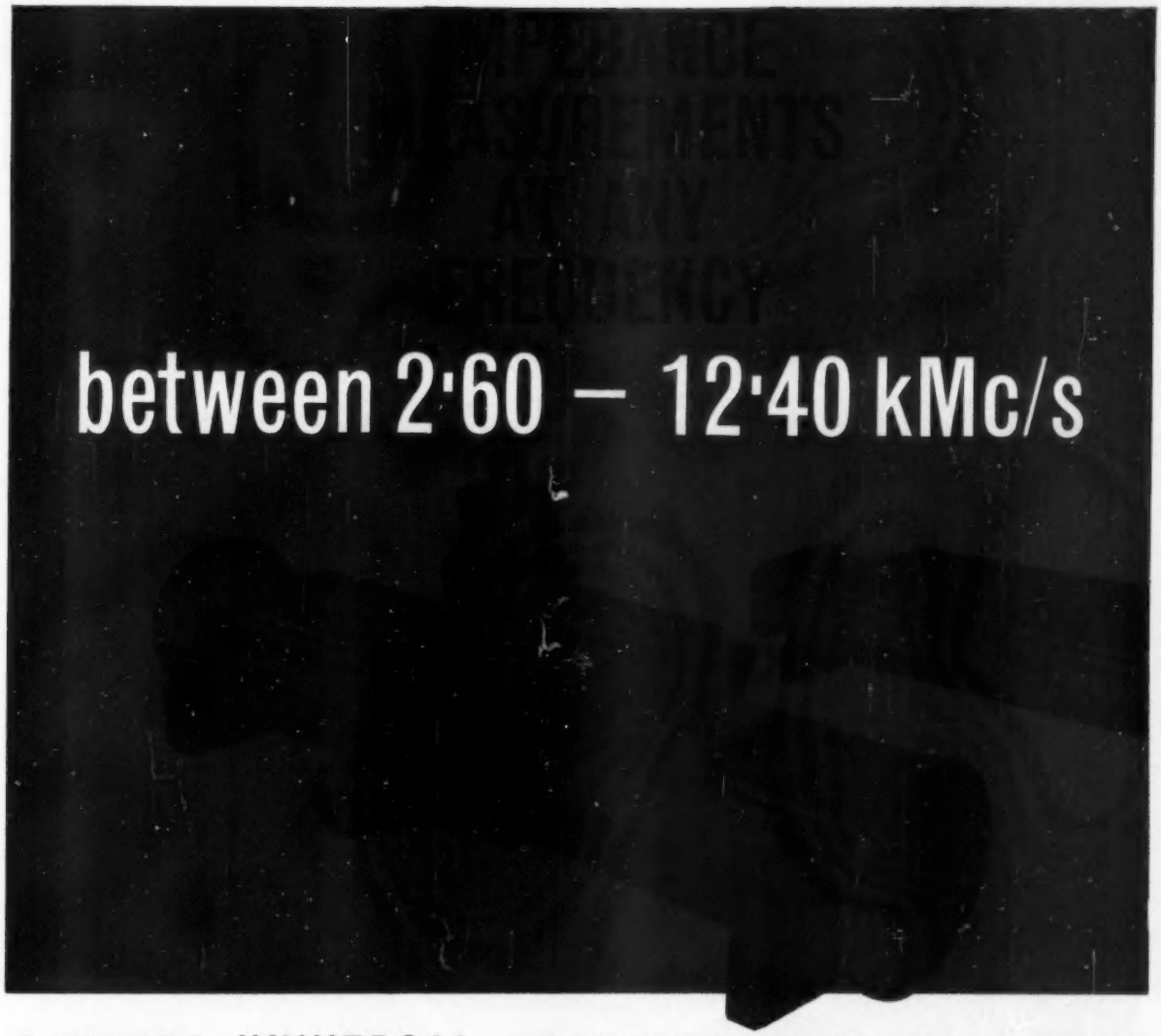
THE THERMAL SYNDICATE LTD.

P.O. Box No. 6, WALLSEND, NORTHUMBERLAND *Tel: Wallsend 62-3242/3*

LONDON: 9 BERKELEY STREET, W.1. *Tel: Hyde Park 1711/2*

* Registered Trade Mark

EE 40 167 *for further details*



SANDERS UNIVERSAL STANDING WAVE DETECTOR

Utilising a single probe carriage assembly and the appropriate waveguide slotted section, impedance measurements to an accuracy of 0.5% can be made within the frequency range 2.60 - 12.40 kMc/s.
Carriage positioning is indicated by a dial gauge and vernier and scale assembly. RF output from the fully adjustable probe is fed direct to a type N connector, or rectified by using a coaxial crystal detector.

Carriage	WG Section	Frequency Range	Price Complete
UPC10/16	WS 16	8.2 - 12.4 kMc/s	£274. 3. 6.
UPC10/16	WS 15	7.0 - 10.5 kMc/s	£274. 3. 6.
UPC10/16	WS 14	5.85 - 8.2 kMc/s	£294. 3. 6.
UPC10/16	WS 13	4.90 - 7.05 kMc/s	£300. 6. 6.
UPC10/16	WS 12	3.95 - 5.85 kMc/s	£314. 11. 0.
UPC10/16	WS 11a	3.30 - 4.90 kMc/s	£320. 16. 6.
UPC10/16	WS 11	3.30 - 4.90 kMc/s	£320. 16. 6.
UPC10/16	WS 10	2.60 - 3.95 kMc/s	£328. 0. 0.

* Note Carriage Assembly type UPC10/16 may be purchased separately Price £205. 0. 0d.
Other waveguide slotted sections within the range 2.60-12.40 kMc/s made to order. Prices on application.

THE Sanders GROUP OF COMPANIES

Gunnels Wood Road, Stevenage, Herts.
Tel: Stevenage 981 Telex: 82159 Sanders, Stev.

MD

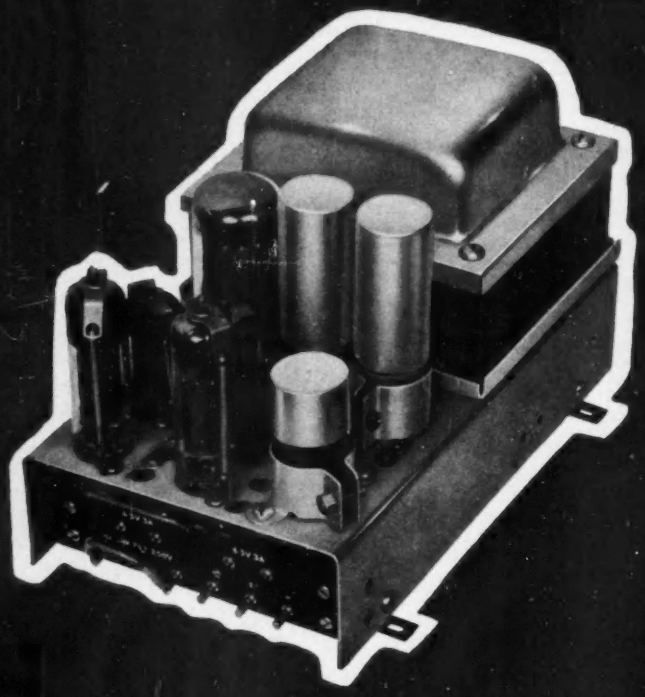
W. H. Sanders (Electronics) Limited

EE 40 169 *for further details*

Todays finest value for only £20

STABILISED POWER SUB-UNIT

MODEL 4931



This very small unit, supplying **250** or **300 V.D.C.** at **150 mA.** max. is ideal for building into your equipment. At this price, with a stability of ±0·1% it is no longer worthwhile designing your own power pack.
Write for further details of this unit and its companion model 4964 providing 150V. or 200V. at 150 mA.

ELECTRONIC INDUSTRIES LIMITED

CHERTSEY ROAD
BYFLEET, SURREY

BYFLEET 41131/2/3/4 PABX
GRAMS: APTRAN, BYFLEET

When this sort of hieroglyph was in common use, ceramics only meant pottery, such as this beautiful Egyptian bowl now in the British Museum. That was in B.C. 1961.

In A.D. 1961, Brush Crystal Co. Ltd. manufactures, under exclusive U.K. licence, a whole family of Lead Zirconate Titanate ceramics. These are the most advanced type of piezo-electric ceramics available and have the trade name 'PZT'.
PZT ceramics will solve your transducer problems, so ask for details from :—

BRUSH CRYSTAL CO. LTD.
Hythe,
Southampton,
Telephone: Hythe 3031

It costs no more to buy the best when you specify..

Servomex

Servomex Instruments and Controls for Research, Industry and Education include
A.C. Supply Stabilisers
Precision Motor Control Systems
Test Equipment for Automatic Control Systems
Chemical Process Control
Industrial Servo Controls
and Mechanical Components
Tools for Teaching Control Techniques
Stabilised D.C. Power Supplies.

SERVOMEX CONTROLS LIMITED

Servomex price list

This list is effective September 18th, 1961

	U.K. price (delivered)	F.O.B. Charge	Export price (F.O.B. or at Airport)
MISCELLANEOUS EQUIPMENT	£	£	£
ES.1B Instructional servo system (designed by Feedback Ltd.)	330	22	352
TFA.46 Transfer function Analyser	2300	40	2340
LF.51 Low frequency waveform generator (*with wooden ends*)	395	10	405
RG.77 Random signal generator (*with wooden ends*)	180	10	190
FP.92 Field Plotter	33	Nil	33
Resistance Paper 33/– for roll 50′ × 22″ (*width may be increased to 29″ during* 1961, *but no price change*)			
Silver conducting paint 49/– for a ¼ lb. pot			
Decade Capacitor, type B	21	Nil	21
A.C. VOLTAGE STABILISERS			
AC.2 Mk. IIA 2 KVA, rackmounting	87	10	97
AC.2 Mk. IIB 2 KVA, rackmounting	99	10	109
AC.7 7 KVA, rackmounting	143	10	153
STABILISED D.C. POWER SUPPLIES			
DC.56 3—30V 0—40A	445	25	470
DC.58 6—60V 0—20A	445	25	470
DC.59 12—120V 0—10A	445	25	470
DC.60 24—240V 0—5A	445	25	470
DC.65 6—14V 0—1A	39	5	44
DC.68 250—350V 0—150mA	40	5	45
DC.84 0—72V 0—1.5A (*with wooden ends*)	183	10	193
DC.105 Twin Supply, plus and minus 300V 0—50mA	57	5	62
DC.112 300V 0–250mA	59	5	64
HIGH PRECISION SERVO SPEED CONTROLLERS			
MC.43 95 watt, rackmounting (*less motor*)	150	10	160
MC.47 350 watt, rackmounting (*less motor*)	192	10	202
Motor for MC.43, with lead and plug	35	4	39
Motor for MC.47, with lead and plug	95	10	105
SERVO SUB ASSEMBLIES			
SA.61 Servo-amplifier	17	Nil	17
AS.69 Armature supply 0.5 Amps.	22	5	27
CHEMICAL INSTRUMENTS DIVISION			
D.C.L.83 Servomex-DCL Oxygen Analyser (*less recorder and sampling equipment*)	800	25	825
G.S.96 Gas Sampling Panel	98	10	108
D.C.L.101 Portable Oxygen Analyser	216	5	221
D.C.L.104 Infra-red analyser (*provisonal price*)	1400	25	1425

NOTES

(1) *WOODEN ENDS. The instruments specified as rackmounting fit the standard 19″ rack. When not used in a rack they need the SERVOMEX wooden ends to provide carrying handles and protection, the price of which is £4 per pair, home and export.*

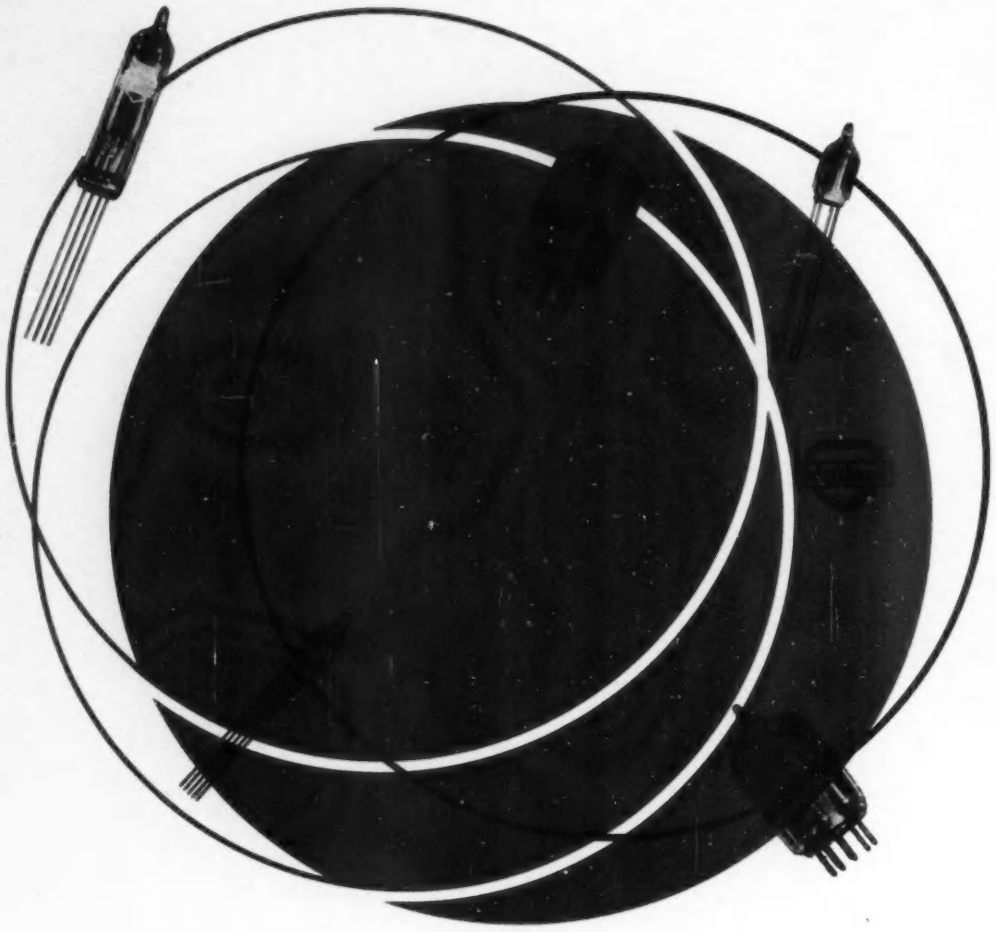
(2) *U.K. PRICE. Routine delivery is included, but if special "express" service, e.g., passenger train is demanded, it will be charged at cost. Customers in U.K. who retain the packing case will be charged half the "F.O.B. Charge" shown in the list.*

(3) *EXPORT PRICE. This price applies to all countries except U.K. (And North America in certain cases). Our agents abroad are authorised to add the cost of freight, duty, etc., but no other "profit" or "mark-up."*

(4) *VARIATIONS from standard colour or design add greatly to the cost of production and will be charged accordingly.*

(5) *DISCOUNTS. These are the lowest profitable prices and there are no trade or educational discounts. Deduct 1½% for cash fifteen days from despatch of goods. Bulk DELIVERY may lower costs and qualify for special discount.*

CROWBOROUGH · SUSSEX · TELEPHONE CROWBOROUGH 1247



how long will a trigger tube last?

25 . . . 50 . . . 100 years?

By means of accelerated life tests carried out in our laboratories, we can now confidently predict the life expectancy of our Cold Cathode Trigger Tubes when used under predetermined conditions.

Extensive tests have shown that the life expectancy of these tubes when used in Business Machines, Telephone Exchange Equipment, and Process Controllers is over 25 years..... when used in R.C. Timers over 50 years..... and in Protection Equipment over 100 years.....

A report describing accelerated life tests on Mullard Cold Cathode Trigger Tubes is available on request. To obtain your copy of this document, just write to Mullard quoting reference D42012.

Mullard
GOVERNMENT AND INDUSTRIAL VALVE DIVISION

MULLARD LIMITED
Government and Industrial Valve Division

Mullard House, Torrington Place, London, WC1 LANgham 5522

HVTB 420

EE 40 174 *for further details*

RUBBER METAL COMPONENTS

The range of Silentbloc products includes a wide variety of devices for noise and vibration reduction, efficient power transmission, instrument protection, power unit location, vehicle suspension and many other purposes in all branches of industry. Weight and power ranges provided for extend from light portable equipment to the heaviest industrial machinery.

Come to us at the drawing-board stage

SILENTBLOC

ANTI-VIBRATION DEVICES
FOR ROAD AND RAIL TRACTION
INDUSTRY • MARINE APPLICATIONS
INSTRUMENTATION • ELECTRONICS

SILENTBLOC LIMITED MANOR ROYAL CRAWLEY SUSSEX

Telephone: Crawley 27733 *Telegrams: Silentbloc Crawley*

Andre Rubber Co. Ltd., is another Silentbloc Company.

Silentbloc products are also manufactured by Silentbloc (Australia) Pty. Ltd., Melbourne Broadway 5/115

EE 40 175 *for further details*

JR

NICKEL SILVER
AND
CUPRO-NICKEL

For Electronics, Radio & Telecommunication Fields . . . . . .

NICKEL SILVER All qualities from 5% Nickel content to 30% Nickel content.

CUPRO-NICKEL All qualities from 5% Nickel content to 45% Nickel content.

SHEET Maximum width 24". Minimum thickness 0.006".
STRIP Maximum width 18". Minimum width ¼". Minimum thickness 0.005"
WIRE Maximum diameter ½". Minimum diameter 0.0025".

Specialities High finish Nickel-Silver Telephone Strip and Sheet conforming to BSS 1824, or to your own specifications for the manufacture of Spring contacts, Relay blades, etc.

We also specialise in producing Copper-Nickel Alloys (Cupro Nickel) with special resistance properties in the form of Sheet, Strip and Wire.

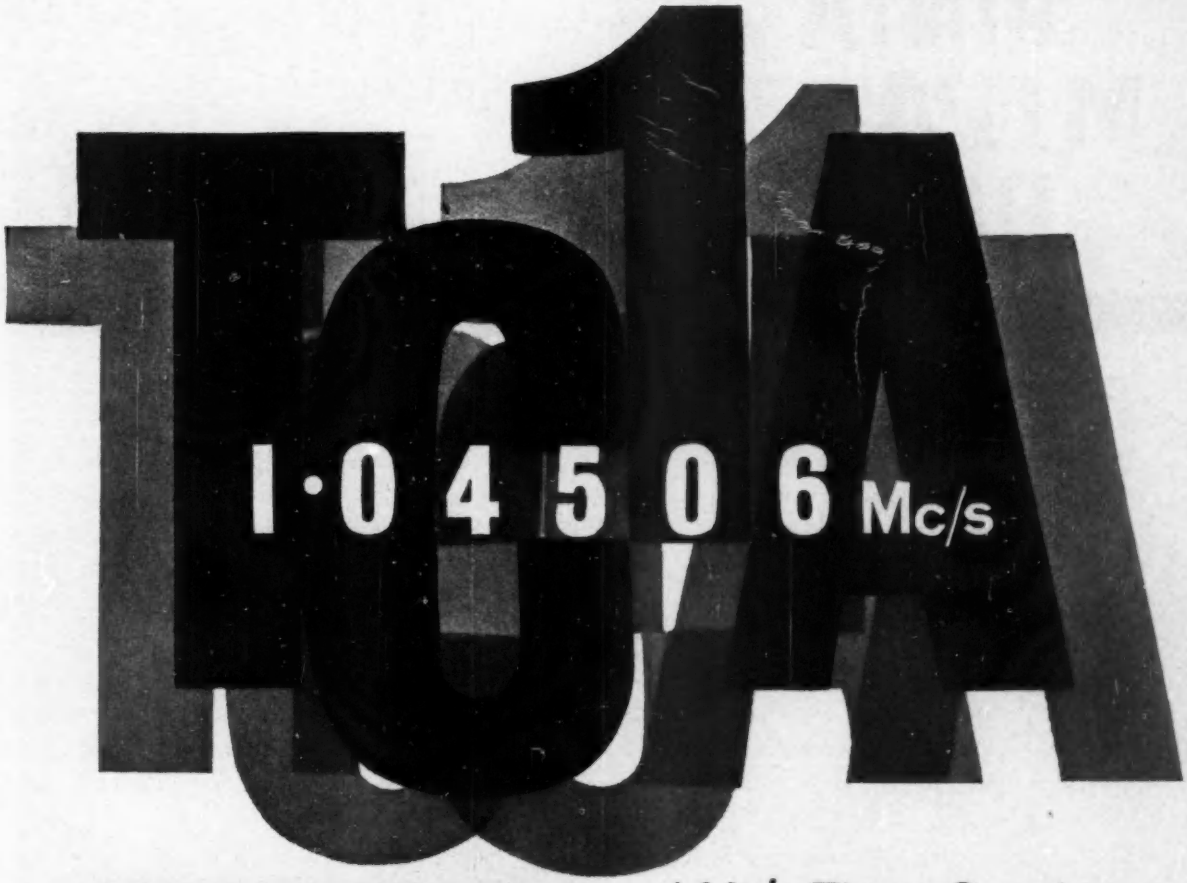
Established 1845

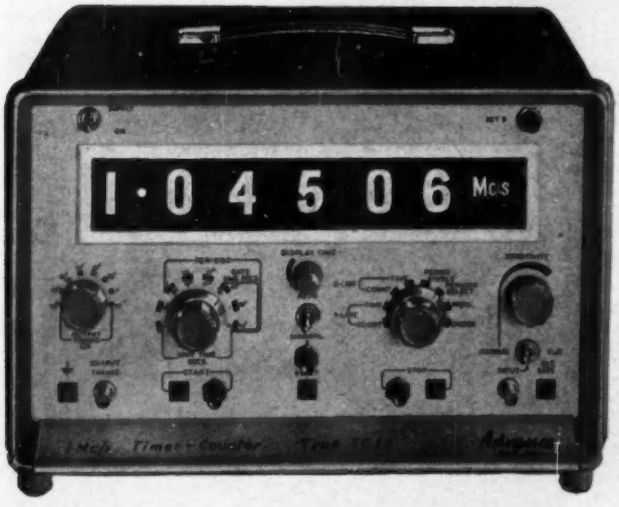
JONES & ROOKE (1948) LTD. NORTHWOOD STREET ROLLING MILLS, BIRMINGHAM 3.

EE 40 176 *for further details*

QUICK ACCURATE READINGS

are possible with the latest timer-counter by Advance which incorporates an easy-to-read in-line display with automatic decimal point and units of measurement indicator. The internal frequency standard is a temperature compensated crystal oscillator which enables accurate measurements to be taken as soon as the instrument is switched on.





1 Mc/s Timer-Counter
TYPE TC1A FEATURES

IMPROVED SIX FIGURE DISPLAY with in-line presentation.
INTERNAL STANDARD is a temperature compensated crystal oscillator accurate to ± 1 part in 10^6 between + 10°C and + 30°C.
FREQUENCY MEASUREMENTS from d.c. up to at least 1 Mc/s.
TIME MEASUREMENTS for any time between 3 μsec. and 2777 hours.
PERIOD MEASUREMENTS for 1, 10, 10^2, 10^3, 10^4, or 10^5, cycles of the input.
PULSE WIDTH MEASUREMENTS are possible.
FREQUENCY MEASURING PERIOD 0.1, 1.0, or 10 secs.
TIMING PULSE OUTPUT from 10^{-1} up to 10^6 pulses per second.
SELF-CHECKING FACILITIES are provided.
AMBIENT TEMPERATURE RANGE 0°C to + 40°C.

NETT PRICE IN U.K. £395

SB1/5

Advance COMPONENTS LIMITED

ROEBUCK ROAD, HAINAULT, ILFORD, ESSEX. TEL: HAINAULT 4444
TELEGRAPHIC ADDRESS: ATTENUATE ILFORD.

EE 40 177 for further details

*DRINKA PINTA MIPA DAY

Clear a lunch space on the desk, pour out the pinta, put your feet up. Lean back, open book, munch sandwich, thank M.I.P.

But why? M.I.P. don't make desks or dairies or double decker sandwiches or detective novels. Not directly, that is. Of course, you might say that they were instrumental.

Crumple the carton, miss the W.P.B. by inches, shut the book, close your eyes, catch a ten-minute nap, thank M.I.P.

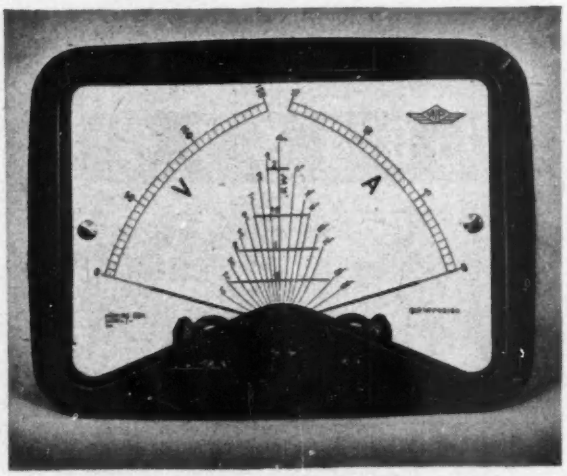
Not that M.I.P. make cartons or wastepaper baskets or book-marks or any of that stationery stuff. They make a point of moving with the times.

And to prove to you just how they move they'll be pleased to send you details of their latest developments in instrumentation. Such as miniature instruments for remote control desks in oil refineries, for instance, or special clear view ranges for industrial switchboards—the kind that are installed in bottling plants. And office equipment manufacturers; so that chaps like you can have desks to put pintas and feet on.

Not to mention *special instruments for plating shops that set a shining example* (see below).

The fact is, if you want instruments — modern, readable, robust, precise instruments; normal or miniature, surface or flush, stock line or special order, just get on to M.I.P. There's no better way.

With acknowledgments to the Milk Marketing Board



CROSS POINTER INDICATOR

For the accurate and rapid control of plating. Comprises an ammeter and a voltmeter housed in one case. Also available with Ohms and Watt scale reading in the centre calibration. Can be supplied for A.C. working, with internal rectifier and current transformer.

MEASURING INSTRUMENTS (PULLIN) LTD.

Head Office: *Electrin Works, Winchester Street, London, W.3.* *ACOrn 4651 and 8801*

London Showrooms: Electrin House, 93-97 New Cavendish Street, London, W.1. LANgham 4551-6

The concept of armoured dispersal in a nuclear war requires long range mobile groundwave inter-communication. For this job the British Army is being equipped with a new wireless equipment—

the C 13

1482P

OUTSTANDING FEATURES
OF THE C13 MILITARY WIRELESS SET

*

ROBUST — FULLY SEALED — WEATHERPROOF
No netting — Crystal calibration
Simple controls — Two-knob tuning

PHASE AND AMPLITUDE MODULATION
4201 channels at 2.5Kc/s spacing
High-frequency band 1.5 to 12 Mc/s

RF OUTPUT 16–25 WATTS
Automatic control of frequency, modulation and gain
Automatic quieting circuits

LOW POWER CONSUMPTION
24 volt power supply — Stand-by (receiver only)
High power/low power switch — IC amplifier

GROUND AND SKY WAVE
Voice and CW — Local and remote aerials
Minimum screening — Vehicle and ground stations

The C13 is the official replacement for the WS19HP set. It provides the extra-long ground-wave ranges required by mobile armoured fighting vehicles on active service with the British Army. Exceptional range, performance, simplicity of controls, rugged climatic protection and the elimination of all netting combine to make the C13 a versatile and highly serviceable equipment. It conforms in all respects to the Joint Services Specification Category K114G. You are invited to write to us for a booklet giving a comprehensive description of the set and its performance.

*

BCC also design, engineer, instal and service complete communications systems. Our Advisory Service would be glad to have the opportunity of helping you

BCC

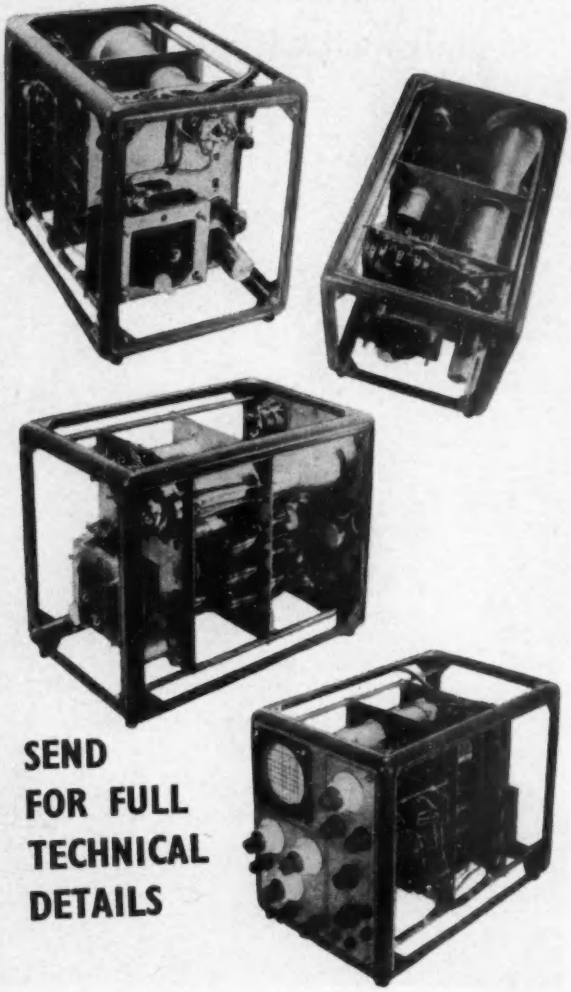
*

BRITISH COMMUNICATIONS CORPORATION LIMITED

HIGH WYCOMBE BUCKS — TEL: HIGH WYCOMBE 2501
Grams: BeeCeeCee High Wycombe — And at Wembley

EE 40 179 for further details

Look into this folder...



SEND FOR FULL TECHNICAL DETAILS

ELECTRONIC EQUIPMENT MANUFACTURERS

MODEL 381. Vertical amplifier bandwidth DC—9 mc/s (–3dB) with rise time of .04 μSec., and overshoot of less than 1%. Calibrated nine stage frequency compensated input attenuator. In addition all the facilities of a high class 3″ general purpose oscilloscope. Unique mechanical construction with all panels removable for ease of maintenance. Convection cooled.

At its price the best value obtainable in this country—perhaps in the world.

Dartronic LIMITED

£36

Telephone: MARyland 6247

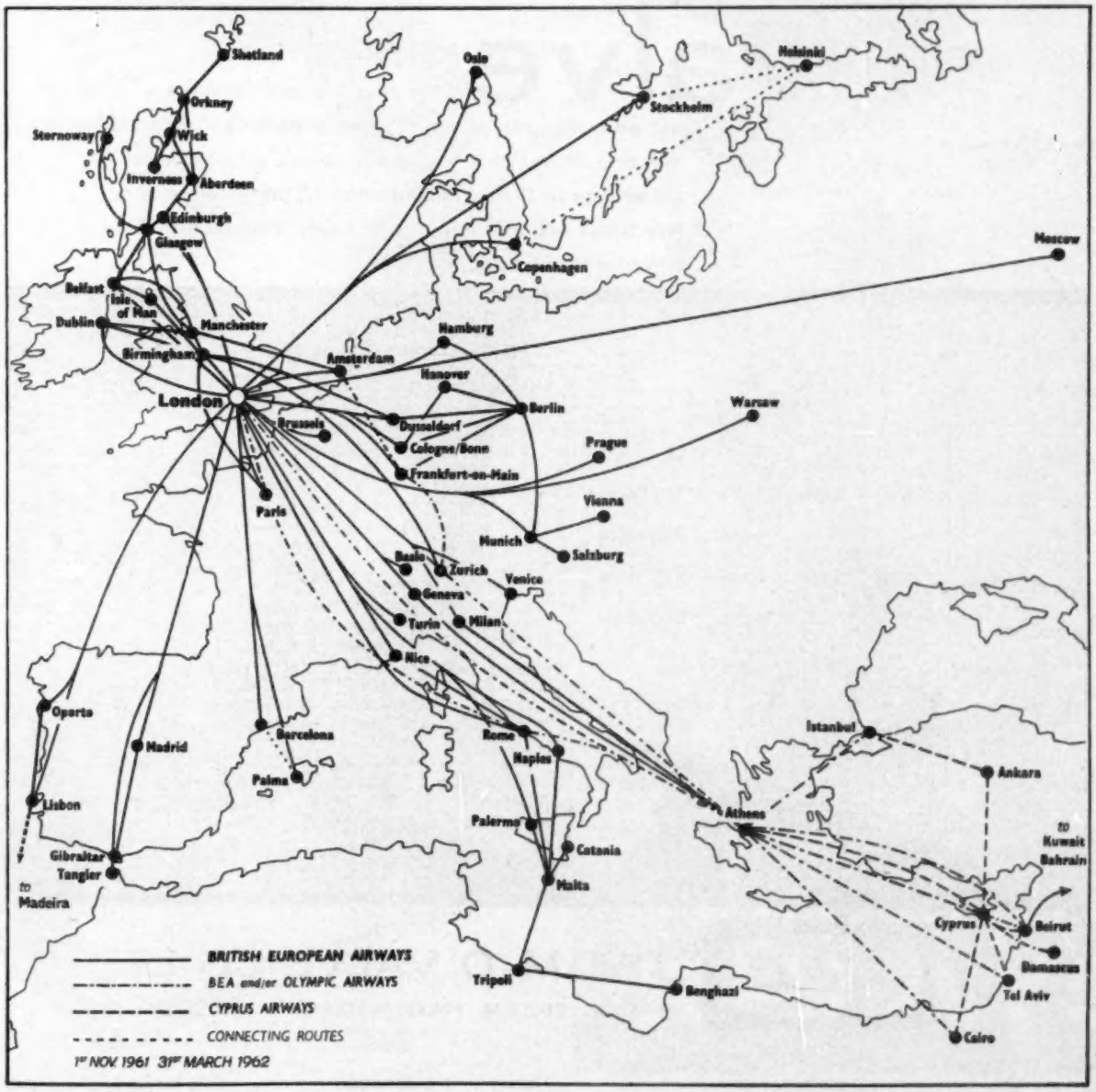
3-7, WINDMILL LANE, LONDON, E.15

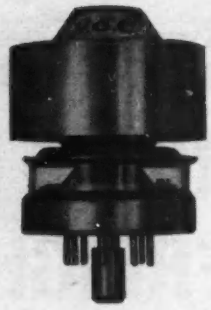
EE 40 180 *for further details*

BEA

LARGEST SCHEDULED CARRIERS OF AIR FREIGHT WITHIN EUROPE

For complete details on how BEA air freight services can help you, contact your nearest BEA office, or consult your usual shipping and forwarding agent.

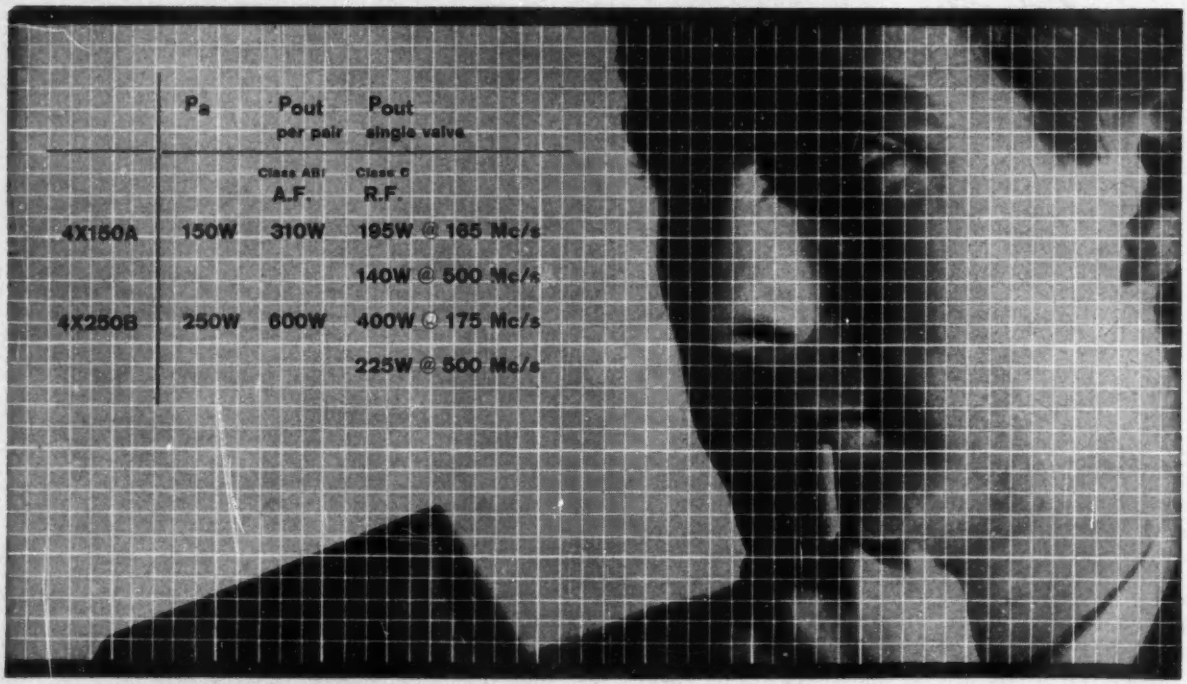




WE CAN GET YOU OUT OF A

transmitting valve PROBLEM

Last year our 300 engineers solved many thousands of valve problems from all sides of industry. If you have a valve problem, why not take advantage of their expert advice? Simply telephone RIV 3431 and ask for our Technical Information Centre or write to the address below.



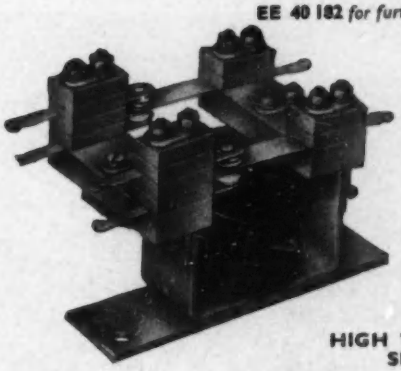
G.E.C.

THE M-O VALVE CO LTD

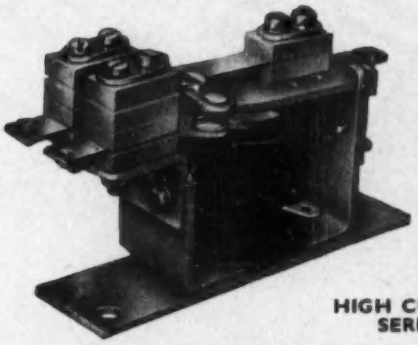
BROOK GREEN HAMMERSMITH LONDON W6

EE 40 182 *for further details*

ELECTRO METHODS LTD

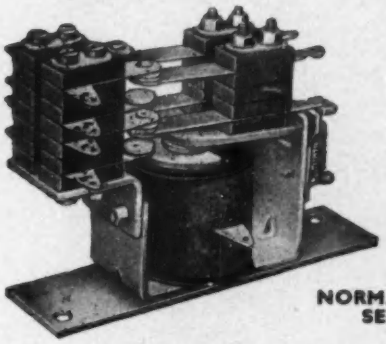


HIGH VOLTAGE SERIES

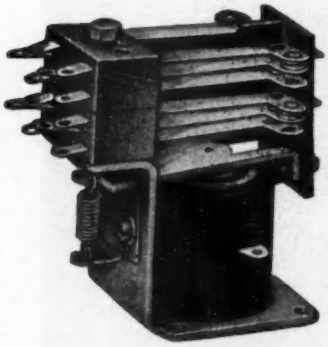


HIGH CURRENT SERIES

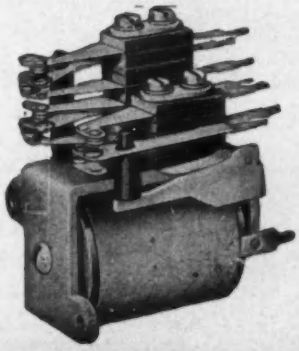
MINIATURE MOVING COIL SERIES



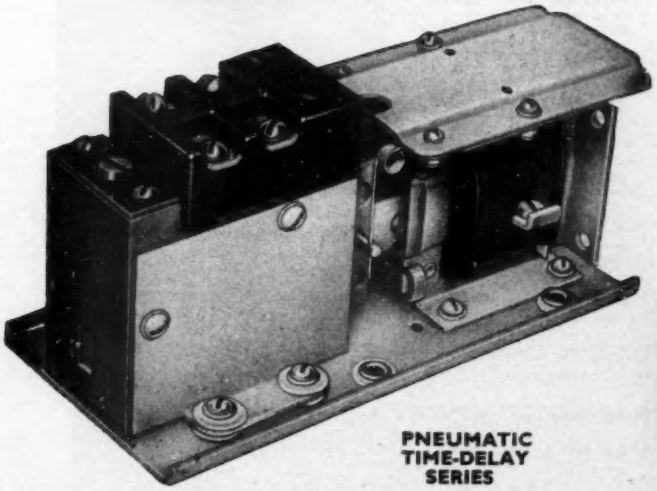
NORMAL DUTY SERIES



GATE OPERATED SERIES



MINIATURE SERIES

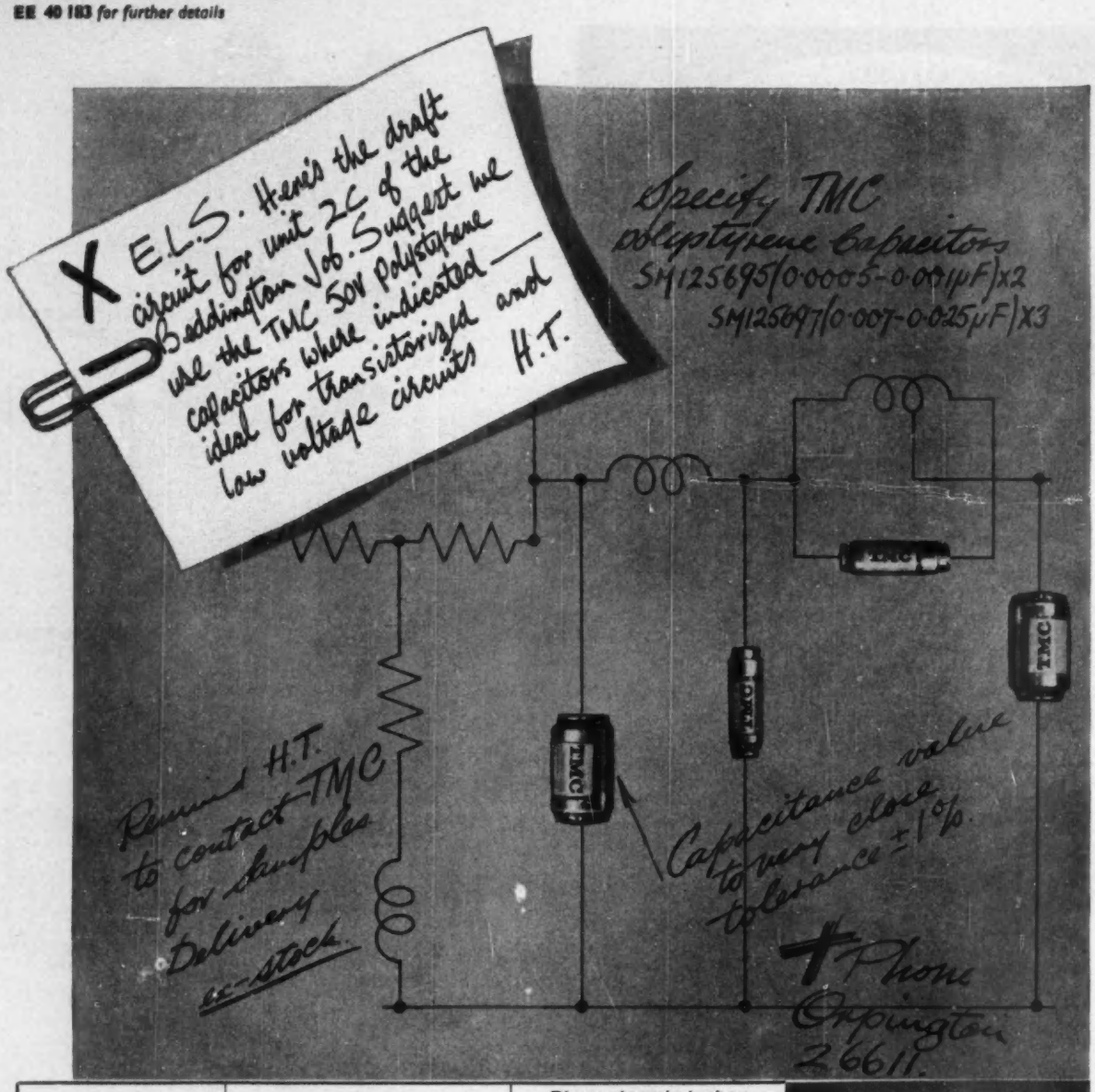


PNEUMATIC TIME-DELAY SERIES

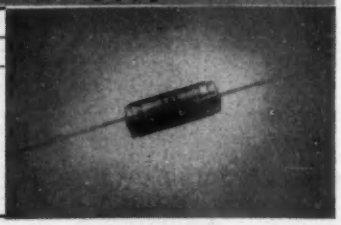
PRECISION RELAYS

Illustrated technical data sent on request:

ELECTRO METHODS LTD., General Products Division, CAXTON WAY, STEVENAGE, HERTS.
Telephone: Stevenage 2110-7


X E.L.S. Here's the draft circuit for unit 2C of the Beddington Job. Suggest we use the TMC 50V polystyrene capacitors where indicated — ideal for transistorized and low voltage circuits H.T.
Specify TMC polystyrene capacitors
SM125695/0·0005-0·001μF/X2
SM125697/0·007-0·025μF/X3
Remind H.T. to contact TMC for samples Delivery ex-stock.
Capacitance value to very close tolerance ±1%.
Phone Orpington 26611.
TMC

Catalogue No.	Capacitance in μF	Dimensions in inches	
		Length	Dia. Max.
SM.125695	0.0005 — 0.001	3/16	1/16
SM.125696	0.001 — 0.007	3/16	1/4
SM.125697	0.007 — 0.025	11/16	11/32
SM.125667	0.025 — 0.1	7/8	17/32
SM.125668	0.1 — 0.2	1 1/16	13/32
SM.125669	0.2 — 0.5	1 1/32	11/32



WKG. VOLTAGE 50V. d.c. **TEST VOLTAGE** 75V. d.c.
INSULANCE 750,000 MΩ or 250,000ΩF whichever is the smaller.
POWER FACTOR ⩾ 0.001 at 1 kc/s. **TEMPERATURE** 70°C. MAX.
CLOSEST STANDARD TOLERANCE ±1% (Closer tolerances may be obtained by selection but a definite price advantage results from specifying the widest tolerance acceptable)

Small enough?
Actual size picture of one of the new TMC polystyrene capacitors: SM. 125695 capacitance 0.0005μF

There are, of course, many other TMC Polystyrene Capacitors for a variety of applications demanding highly stable components—working voltages from 50 to 1,000V d.c. (special high voltage types up to 15 kV d.c.).

TMC

TELEPHONE MANUFACTURING COMPANY LIMITED
Capacitor Division, Sevenoaks Way, St. Mary Cray, Orpington, Kent
Telephone: Orpington 26611
A MEMBER OF THE PYE GROUP OF COMPANIES

EE 40 184 *for further details*

type S.0530

regulation 0.5% from zero to full load.
stability 1% for ±10% mains change.
ripple Less than 0.1%.
Fitted with 5" Ernest Turner Kilovoltmeter and current-metering jack on 19" x 10½" P.O. panel, 14" deep, for rack mounting or bench use.
polarity Either positive or negative grounded.
Models A, B, C and D

£135 *ex works*

reversible polarity.
Models AR, BR, and CR £165 ex works.

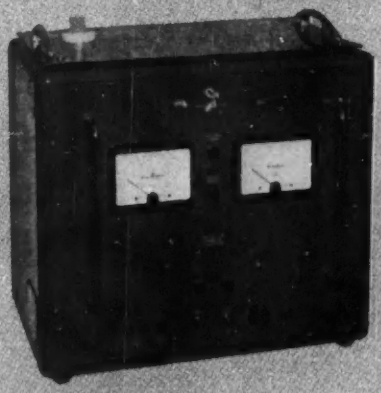
OUTPUT

3 to 30 Kilovolts at ½ mA.	S.0530 Model C
2 to 20 Kilovolts at 1 mA.	S.0530 Model B
1 to 10 Kilovolts at 2 mA.	S.0530 Model A
½ to 5 Kilovolts at 2 mA.	S.0530 Model D

type MR50/R

regulation 0.5% from zero to full load.
stability 0.5% for ±10% mains change.
ripple Better than 1%.
polarity Reversible.
Voltage and current metered.
Overload cut-out fitted.
dimensions Width 24", height 23", depth 15".

£245 *ex works*



OUTPUT
5 to 50 Kilovolts at 1 mA.

type MR100R

regulation 1% from zero to full load.
stability 0.1% for ±10% mains change.
ripple 0.1%.
polarity Reversible.
Voltage and current metered.
Overload cut-out fitted.
dimensions MR100R/1. Width 24", height 40", depth 19".

£525 *ex works*

OUTPUT

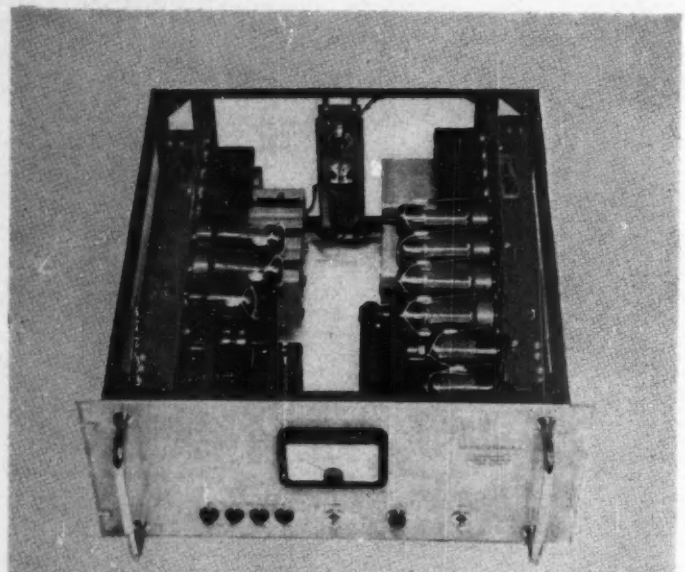
10 to 100 Kilovolts at 1 mA.	MR100R/1
10 to 100 Kilovolts at 2 mA.	MR100R/2

Brochure available on request

BRANDENBURG LIMITED
139 Sanderstead Road, South Croydon, Surrey
Sanderstead 3555/6

INPUT ALL MODELS
200/250 volts 50 cycles
Alternative inputs available for specialized and overseas models
ALL OUTPUTS are continuously variable over the quoted range

high voltage regulated power by BRANDENBURG



V type regulated power supplies

GOOD VENTILATION, EASIER ACCESS. An improved Brandenburg design. The illustration shows two models on one frame measuring 17¼″ x 17¼″ x 7″—one of many methods of mounting these units. All models are voltage stabilised.

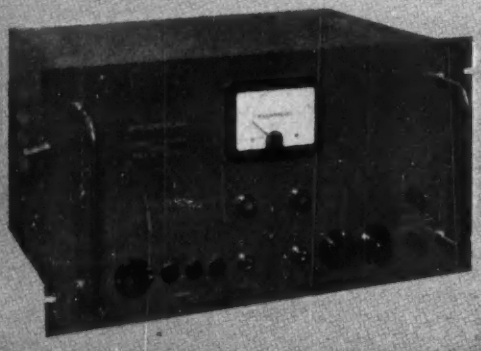
polarity Reversible.
effective resistance 0.1 ohm.
stability 0.02% against ±10% mains change.
ripple Less than 2 mV.

All A.C. outputs can be paralleled. In flanged, open chassis, with frames available for converting all models to front panel mounting.

200, 250, 300 and 350 volt models available. Order thus: V300/100=300 volts at 100 mAmps. Lower and higher voltages and currents also available.

Prices on application.

Models	output A.C.	dimensions D. W. H.	ex works
100 mA.	4 x 6.3V, 1.5A	15¾″ x 5¾″ x 6¼″	£37 10
200 mA.	4 x 6.3V, 1.5A	15¾″ x 5¾″ x 6¼″	£48 10
350 mA.	2 x 6.3V, 5A	15¾″ x 7⅛″ x 7½″	£64
500 mA.	2 x 6.3V, 5A	Two chassis, each 15¾″ x 5¾″ x 6¼″	£80
1 amp. } complete with 19″ front panel, handles and frame			£140
2 amp. }			£230



current stabilised models types C300/C400

output current Continuously variable.
Stability Better than 0.1% against 10% mains change.
Drift Less than 0.5% for 30 minutes.

Enquiries are invited for similar specifications.

Model	output current	output voltage	dimensions D. W. H.	ex works
C300	50-300 mA	500 max.	14″ x 19″ x 10½″	£145
C400	50-400 mA	600 max.	17¼″ x 19″ x 12¼″	£185

INPUTS
200 250 volts 50 cycles
Alternative inputs available for specialized and overseas models

Voltage regulated and current stabilised models will soon be available. Preliminary enquiries invited.

BRANDENBURG low voltage regulated power

scintillation and proportional counter supplies type CS 160

stability Better than 0.1% for ±7% mains change.
effective resistance Less than 1,000 ohms.
ripple Less than 12 mV. peak to peak.
long-term drift Less than 0.1% over 24 hours.

Fitted with two potentiometers, each giving 500 volts to 2 kilovolts output, with coarse and fine controls. Input to potentiometers metered by Ernest Turner Model 703. On 19″ x 7″ P.O. panel, enclosed for rack mounting or bench use.

£195 *ex-works*

output
2.2 Kilovolts at 3 mA

type CS 3520

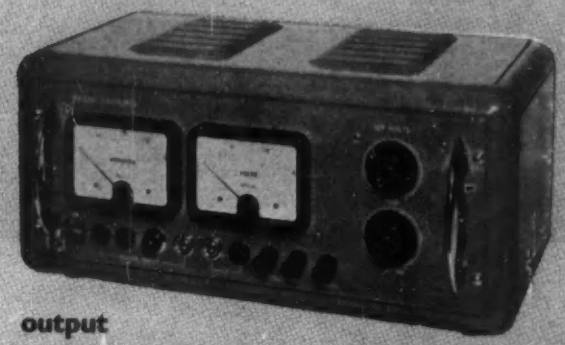
stability 0.1% against 10% mains change.
regulation 0.1% no load to full load.
ripple Less than 10 mV. peak to peak.
polarity Negative output, positive grounded.
In totally enclosed case with P.O. Panel 19″ x 10½″.

output
3.5 Kilovolts at 20 mA maximum.

transistorised variable power type TC 302

output current 2 amps.
impedance Less than 0.1 ohm.
regulation 0.1% against ±5% mains change.
ripple Less than 2 millivolts.
Voltage and current metered by Ernest Turner Model 703.
Dimensions: Depth 9″, width 17¾″, height 7¾″.

Further specifications and quotations available on request.



output
0-30 volts, continuously variable

COMPOSITE POWER SUPPLIES
Brandenburg give prompt delivery on individually specified rack units. These units may incorporate a number of standard and special high and low voltage and transistorised regulated supplies.
Prompt quotations available on enquiry.

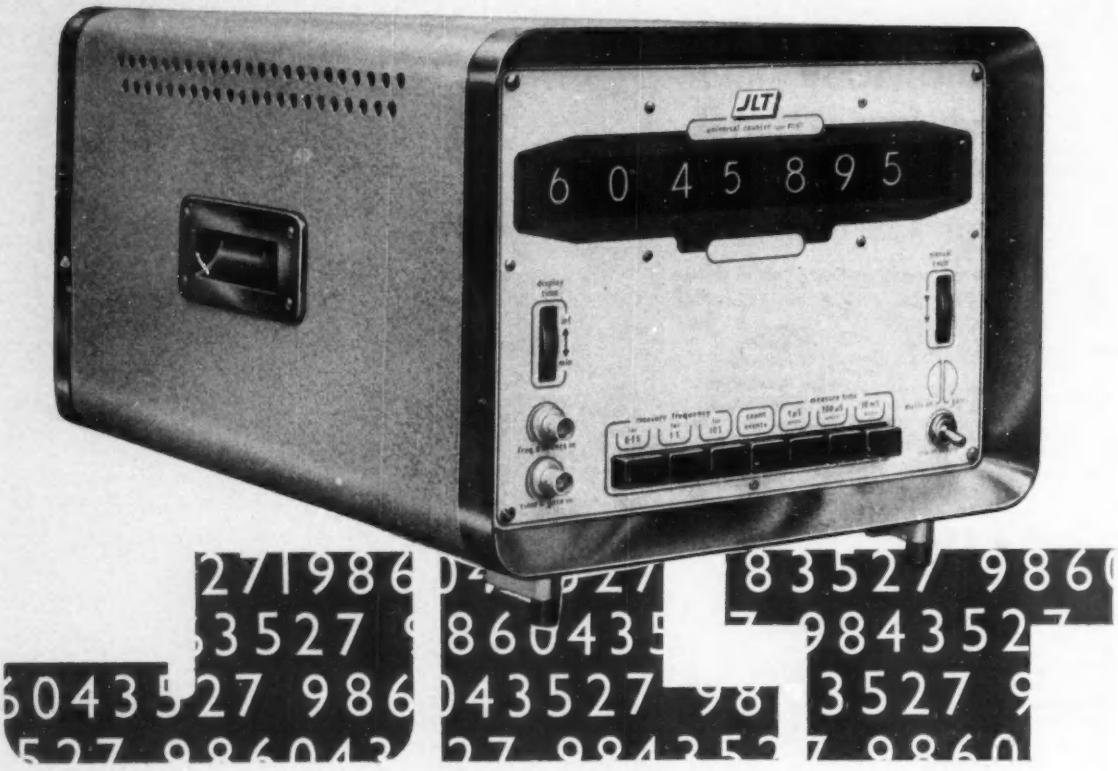
Specifications and quotations for all Brandenburg specialized equipment will be provided on request

BRANDENBURG LIMITED,
139 Sanderstead Road, South Croydon, Surrey
Sanderstead 3555-6

—and special purpose supplies

BRANDENBURG

EE 40 187 *for further details*



TRANSISTORISED UNIVERSAL COUNTER

SERIES 6010/7

7 DIGIT READ OUT

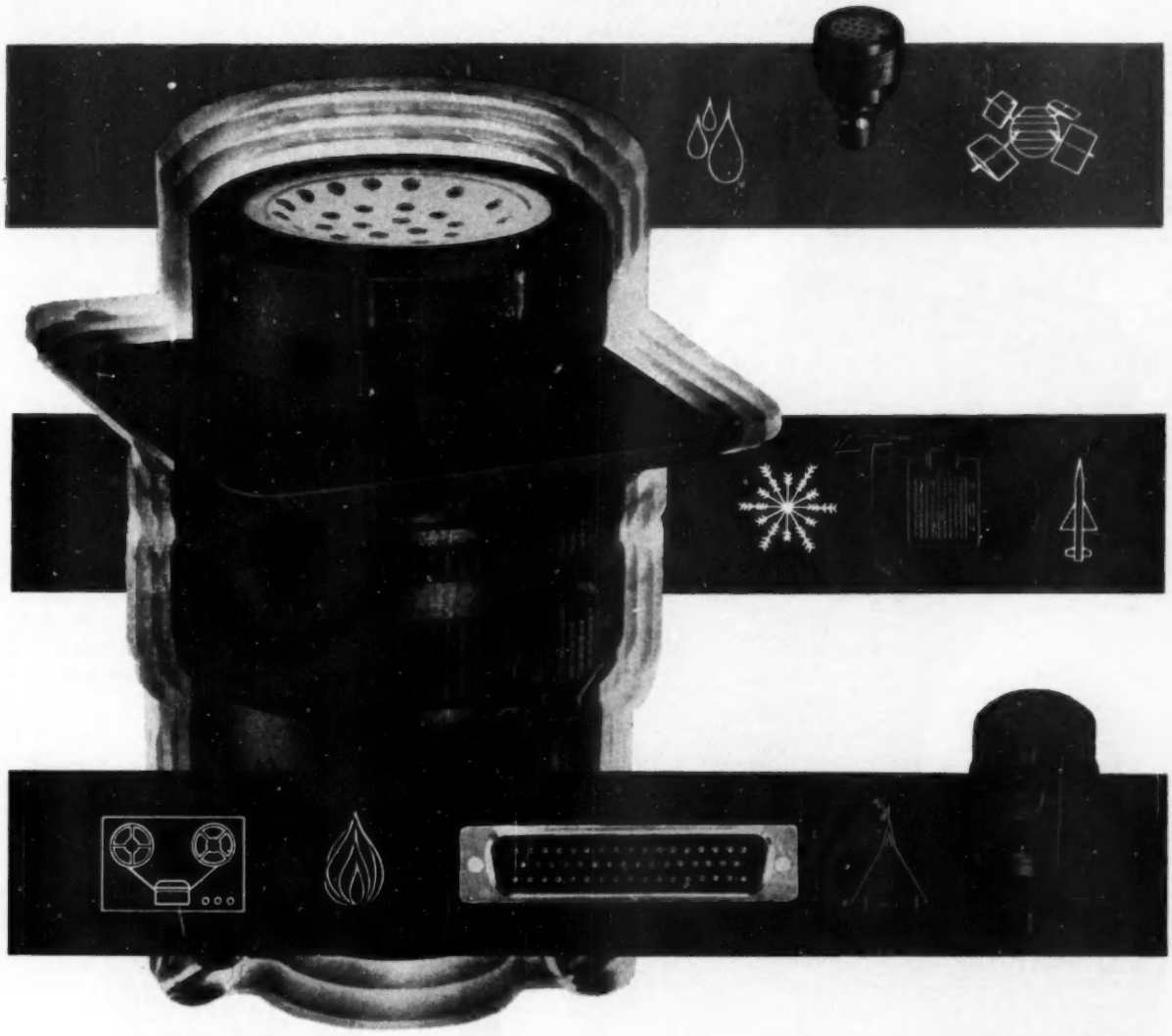
PUSH BUTTON CONTROL

- Simple push-button selection for measurement of frequency, time, counting events and comprehensive self-checking on all ranges.
- *Counting speeds up to 1Mc/s.* Time measurement to 1μsec.
- Over-all accuracy $\pm$ one count $\pm$ one part in 10^7.
- Standard output frequencies from 1Mc/s to 1 c.p.s. per second.
- Decimal output for operating remote indicators or print out.

J. LANGHAM THOMPSON LTD.

BUSHEY HEATH · HERTFORDSHIRE · ENGLAND

Telephone: Bushey Heath 2411 (6 lines) Grams & Cables: "Tommy Watford"



CANNON PLUGS FOR ANY APPLICATION OR ENVIRONMENT

AVAILABLE THROUGHOUT THE WORLD— The famous quality and engineering that have made Cannon Plugs the standard of the industry are available *anywhere in the world!* Our plants in six countries and representatives and inventories in all major cities, provide a direct source for electrical connectors. Whatever your application or environmental requirements — SHOCK ☐ VIBRATION ☐ TEMPERATURE ☐ ALTITUDE ☐ MOISTURE ☐ MINIATURIZATION...Wherever you are located, *Europe, Asia, South America, Australia,* your Cannon sales representative can provide engineering assistance and prompt delivery of electrical connectors to meet your specifications. For further information write to:

CANNON PLUGS

CANNON ELECTRIC (Great Britain), LTD., 168-172 Old Street, London E.C.1., England

EE 40 189 *for further details*

BLUE ARROW SERVICE

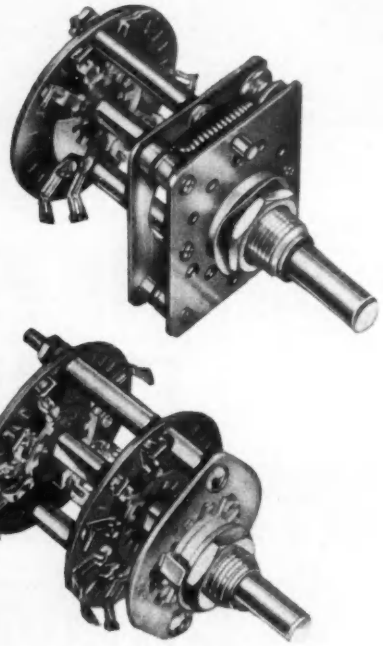
Custom-built switches in 7 days

Introducing BLUE ARROW, a new super speed delivery service on Plessey GA2 rotary switches. Up to 50 switches can be supplied within 7 days. Specially designed to assist development engineers to obtain factory-made switches to individual requirements.

BLUE ARROW service covers type-approved switches as well as switches for domestic radio and television equipment.

For telephone orders under this scheme please ring Havant 991.

Take advantage now of this high speed BLUE ARROW service — write or 'phone for full details.



Plessey

THE PLESSEY COMPANY LIMITED
Components Group, Industrial Electronic Components Division, Havant, Hampshire
Telephone: Havant 1701
Overseas Sales Organisation: Plessey International Limited • Ilford • Essex.

SILVER STAR CAPACITORS

encapsulated

Here are two new silvered mica capacitors for use in filters and other professional equipment.

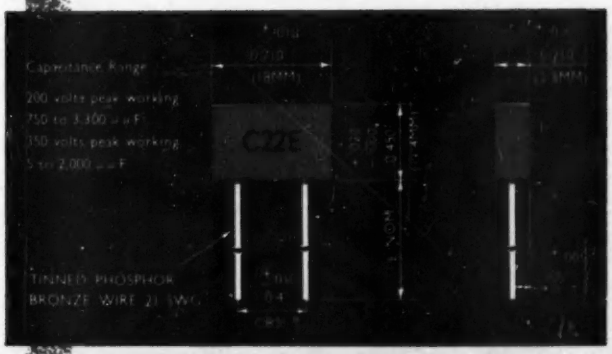
Synthetic resin encapsulated, they can be used either on printed circuits or in conventionally-wired assemblies. The encapsulation technique employed, in conjunction with Silver Star fired construction, ensures outstanding long-term and cyclic stability

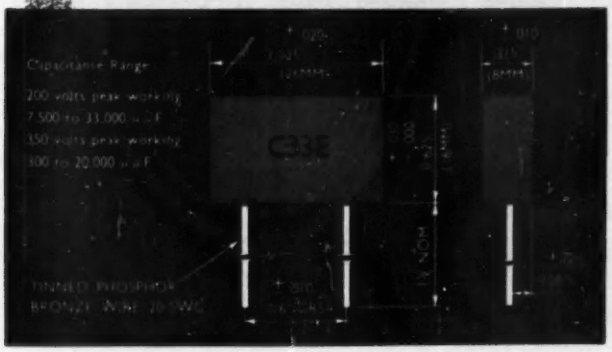
Two sizes (C22E and C33E) together cover the capacitance range 5 to 33,000$\mu\mu$F with a minimum tolerance of $\pm 0.5\%$ for values above 200$\mu\mu$F.

- Precise rectangular section*
- Parallel terminations for 0.1 inch or 0.2 inch module printed circuits
- Service temperature range -55°C to $+100^{\circ}$C
- Conform to Class HI of British Services' Climatic Specification
- Fired construction
- Exceptional long-term and cyclic stabilities
- Pass Services' requirements for solderability and ruggedness
- Two peak working voltages: 200 and 350
- Silver Star (R) quality

* *Both body sizes conform to American and NATO specifications*
Body size of C22E conforms to British Defence Specification

Filter unit by Ericsson Telephones Limited incorporating both types





One of the specialised products of

Johnson Matthey

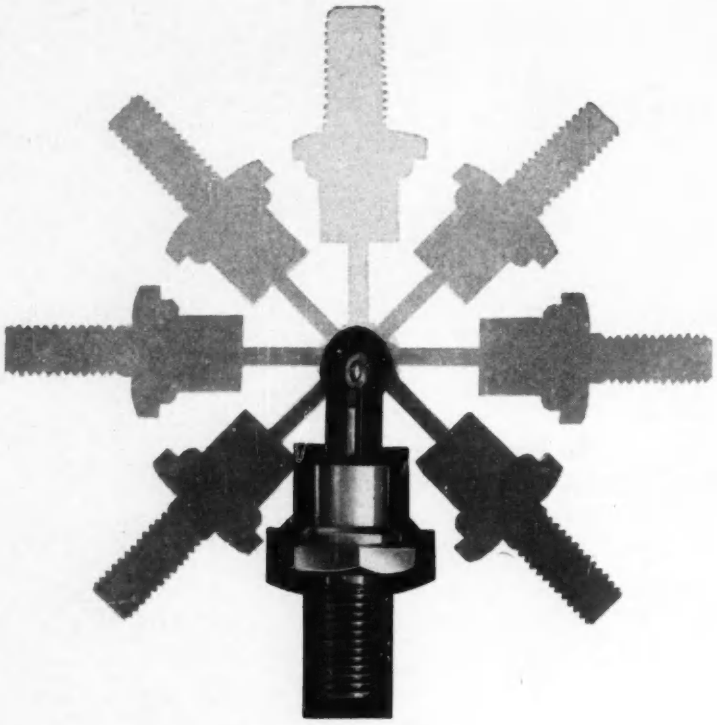
JOHNSON, MATTHEY & CO., LIMITED
73-83 HATTON GARDEN, LONDON, E.C.1
Telephone: Holborn 6989

Vittoria Street, Birmingham, 1. *Telephone: Central 8004*
75-79 Eyre Street, Sheffield, 1. *Telephone: 29212*

EI 1/670

EE 40 191 *for further details*

IMMEDIATE AVAILABILITY-



NEW 4-5A, 200-800V RANGE of Mullard Power Rectifiers

BYZ13, BYZ12, BYZ11 and BYZ10—a new Mullard range of silicon double diffused diode rectifiers for use in the current range 0.5 to 4.5A. These devices are particularly suitable for intermediate power applications and feature a high P.I.V. and low forward voltage.

The forward voltage drop at 5A is 1.5V and the maximum junction temperature is 150°C with maximum recurrent P.I.V. of 200V (BYZ13), 400V (BYZ12), 600V (BYZ11), 800V (BYZ10).

These rectifiers—encapsulated in a stud-mounting, hermetically sealed, all metal envelope—are now in large scale production to ensure immediate availability and a price range which is both realistic and economical.

Additional details on this new range of rectifiers—and information on every other semiconductor device manufactured by Mullard—appear in the new and enlarged edition of "Designers' Guide" to be published in January. No semiconductor user can afford to be without this invaluable publication—if you are not already on our mailing list write and reserve your copy now.

Mullard
semiconductors for industry

For **immediate** inform tion and data sheets on these Mullard intermediate power rectifiers, write to Mullard quoting ref. D.5512.

MULLARD LIMITED, Semiconductor Division, Mullard House, Torrington Place, London, WC1 Telephone: LANgham 6333

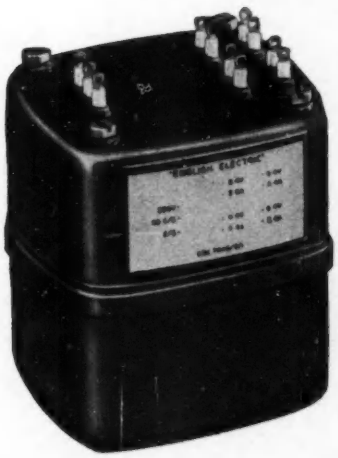
Mullard

MIS.55

EE 40 192 *for further details*

'C' CORES

for more efficient transformers



'ENGLISH ELECTRIC' manufacture a range of 'C' cores to satisfy the most exacting demands of the electronic industry. Leaders in the development of strip-wound cores, 'ENGLISH ELECTRIC' manufacture the full range of 'C' cores in ·013″, ·004″ and ·002″ grain-oriented steel strip complying with the requirements of the Standard Interservice range (RCL.193). Special cores can also be supplied on request.

'ENGLISH ELECTRIC' 'C' cores are suitable for use in oil filled, open type, or resin cast transformers. Clamping frames and other accessories are available and manufacturers can obtain many of their component requirements from 'ENGLISH ELECTRIC'.

Send enquiries, or for Publication TF/239 to:

The ENGLISH ELECTRIC Company Limited,
Transformer Sales and Contracts Section,
East Lancashire Road,
Liverpool, 10.
Telephone: Aintree 3641

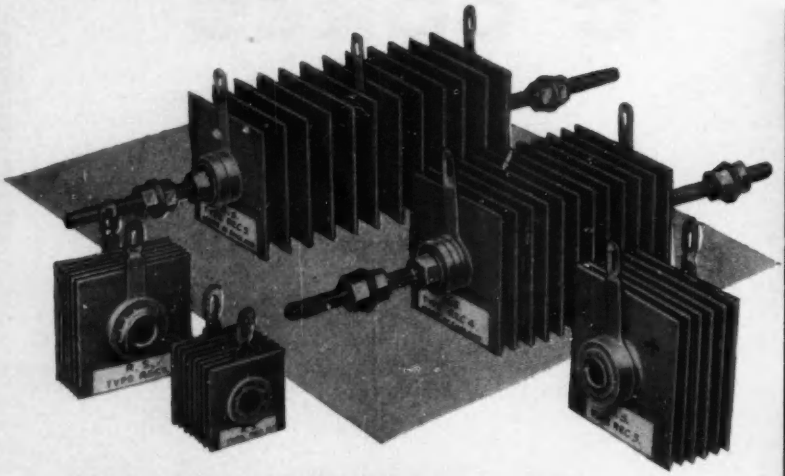
'ENGLISH ELECTRIC'

'C' and 'E' cores

The English Electric Company Limited, English Electric House, Strand, London, W.C.2

TFL.44

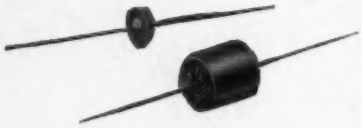
EE 40 193 *for further details*



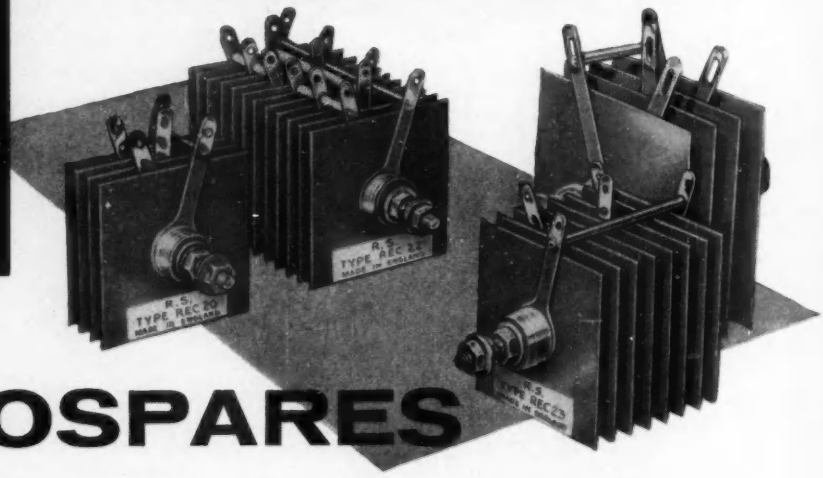
A.C. D.C.

RELIABLE

Order with confidence from our very large range



RECTIFIERS



by

RADIOSPARES

SELENIUM
SILICON
LOW & HIGH VOLTAGE
LOW & MEDIUM CURRENT

Remember – our catalogue lists a vast range of other guaranteed components backed by our "By-Return" delivery service.

Radiospares Ltd.

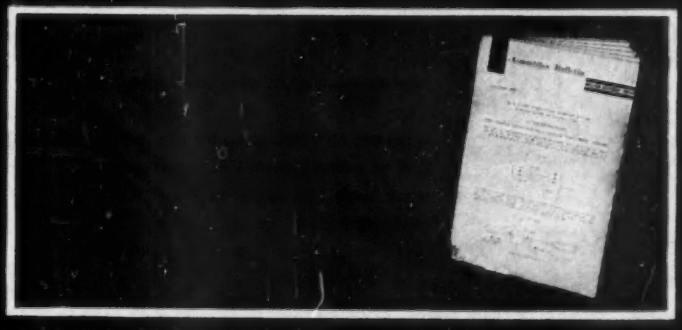
4-8 MAPLE STREET · LONDON · W.1 · ENGLAND

Telephone: EUSton 7232 (8 lines)

TELEGRAMS: RADOSPERES, WESDO, LONDON *CABLES:* RADOSPERES, LONDON—W1

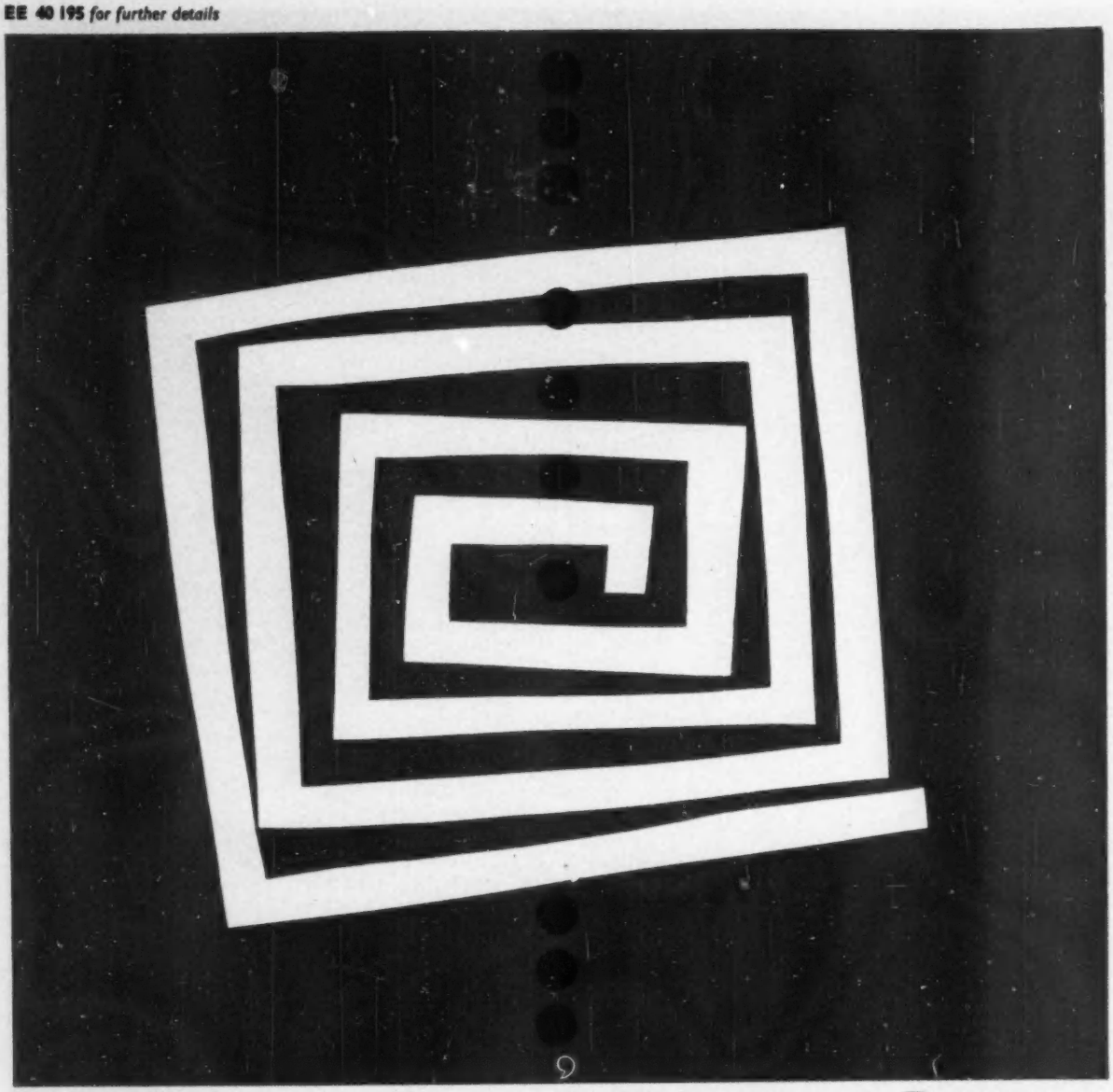
EE 40 194 *for further details*

Circuit blocks cut costs



ME 683

EE 40 195 *for further details*



WE DON'T KNOW

. . . the pattern of glass usage in the electronics industry . . . how many different kinds of glass are used . . . what it is mostly used for . . . or all the possible applications you have for it. But we do know how to make the finest glass available, whatever your needs. If these are for optical or other technical glasses, we're experienced enough to know the right answers, and would like to hear from you.

CHANCE-PILKINGTON OPTICAL WORKS C/P Pilkington Brothers Ltd · Glascoed Rd · St. Asaph · Flintshire · Gt. Britain

IMPROVED PERFORMANCE
COMPONENT ECONOMY

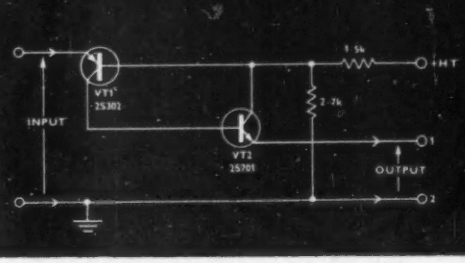
LOW COST

with Complementary Silicon Transistors

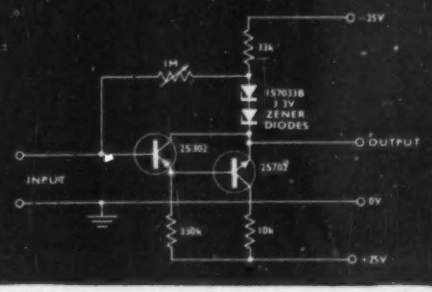
PNP + NPN

TYPE	DESCRIPTION	POLARITY	V_{CB} max. (V)	V_{CE} max. (V)	P_{tot} max. @ 50°C ambient (mW)	I_C max. mean (mA)	h_{fe} min.	(@ 1mA) max.	f_α (Mc/s)
2S301	High voltage type.	PNP	60	60	200	50	10	40	1·0
2S302	Low gain general purpose transistor.	PNP	25	25	200	50	15	50	1·0
2S303	Medium gain general purpose transistor.	PNP	25	25	200	50	25	75	2·0
2S701	Low gain general purpose transistor.	NPN	25	25	100	20	15	50	8
2S702	Medium gain general purpose transistor.	NPN	25	25	100	20	30	90	12
2S703	High gain general purpose transistor.	NPN	25	25	100	20	60	250	16

A COMPLEMENTARY BISTABLE CIRCUIT



A D.C. IMPEDANCE CONVERTER



- Lower leakage currents
- Wider range of pulse repetition rates by simple variation of a potentiometer
- High pulse currents (100mA into 50Ω)
- Low transistor dissipation and low overall power consumption
- Fast rise times
- Simple synchronisation of pulses
- Simple control of phase shift between output pulses and sync. pulses
- Operation up to 80°C and down to −50°C

Applications include: Timing circuits — Trigger circuits for Silicon Controlled Rectifiers — Variable mark/space ratio generators — Pulse generators

- Input impedance = 2MΩ
- Output impedance = 1kΩ
- Current drift for 25°C to 75°C temperature change = 1μA (e.g. with 10kΩ source resistance equivalent voltage drift at the input terminals = 100mV = 2mV/°C)

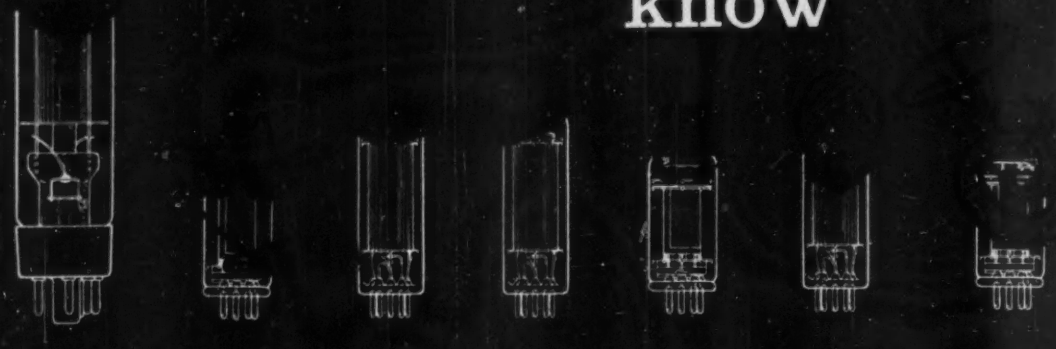
● WRITE TODAY FOR FULL DETAILS of circuit applications and data sheets for all Texas semiconductor devices

RELIABILITY, VERSATILITY—TEXAS SERVICE IN SEMICONDUCTORS

TEXAS INSTRUMENTS
LIMITED
MANTON LANE · BEDFORD · ENGLAND
BEDFORD 67466 · CABLES: TEXINLIM, BEDFORD
310/A2

EE 40 197 *for further details*

all manner of know



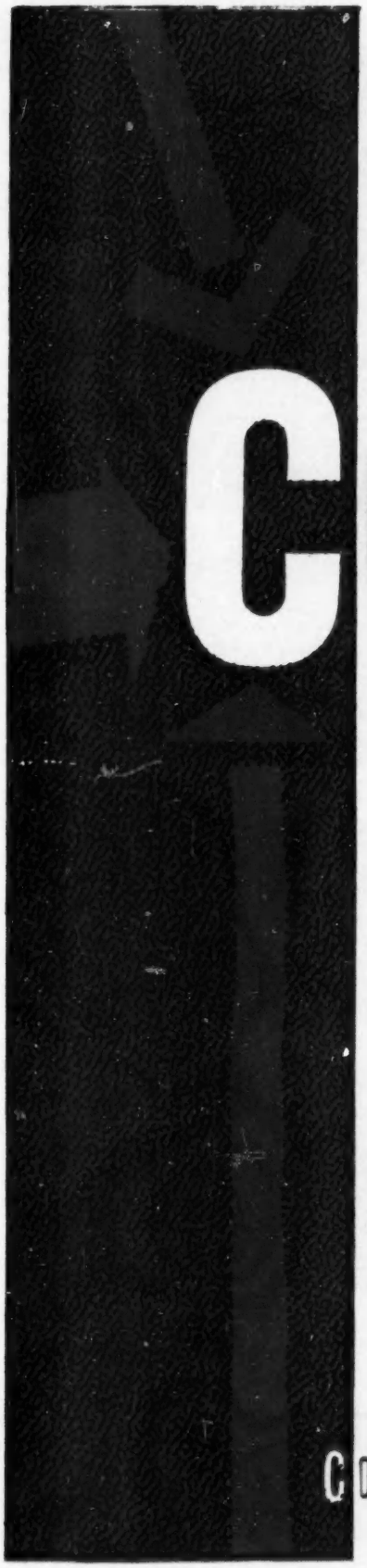
E.T.L. TYPE	RUNNING VOLTAGE	CURRENT RANGE mA	MAX. REGULATION OR IMPEDANCE	RUGGEDIZED	CV TYPE	USA	CONNECTION
GD.75.P.	75	2—60	8.0V	—	—	OC2	B.7.G
GD.83.M.	83	3.5—6.0	350Ω	—	—	—	B.7.G
GD.85.WR.	85	0.5—5.0	5.0V	INDUSTRIAL SPEC.	—	—	B.8.D/F
GD.85.M/S.	85	1—10	4.0V	—	CV449	OG3	B.7.G
GD.85.M/R.	85	1—10	4.0V	INDUSTRIAL SPEC.	—	—	B.7.G
GD.85.P/R.	85	1—10	4.0V	FULL SERVICES SPEC.	CV4048	—	B.7.G
GD.86.W/S.	86	0.05—1.0	5500Ω	—	CV2321	—	WIRE LEADS
GD.87.M.	87	1.5—3.5	3.0V	—	CV2573	5651	B.7.G
GD.90.M.	90	1.0—40	14V	—	—	—	B.7.G
GTR.95.M/S.	95	2—10	5V	—	CV286	—	B.7.G
GTR.150.M/S.	150	2—20	5V	—	CV287	—	B.7.G
GD.150.M.	150	5—30	6V	—	—	—	B.7.G
GD.150.M/S.	150	5—30	6V	—	CV1832	OA2	B.7.G
GD.150.M/R.	150	5—30	6V	INDUSTRIAL SPEC.	—	—	B.7.G
GD.150.A/S.	150	5—40	5.5V	—	CV216	OD3	I.O.
GD.150.P.	150	5—15	5V	—	CV2225	6354	B.7.G

For more detailed information please write to

TUBE DIVISION
BEESTON · NOTTINGHAM

ERICSSON

ERICSSON TELEPHONES LTD · HEAD OFFICE · 22 LINCOLN'S INN FIELDS · LONDON, WC2
ER.20



The PATTERN of PROGRESS POINTS to

COLVERN

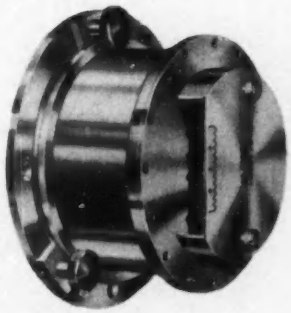
Wire Wound

POTENTIOMETERS

The search for greater accuracy is never ending and Colvern have for 30 years led the way in the development of Precision and Standard Wire Wound Potentiometers. The world's most extensive range by one manufacturer include Standard, Sealed Tropical, Helical and Sine/Cosine Types, many with Cam-Correction devices.

Illus rated is one of such 36 Basic Types.

TYPE CLR 95/00 SINE/COSINE
Brief Specification



RATING	**10 watts**
RESISTANCE RANGE	**10,000Ω—50,000Ω**
RESISTANCE TOLERANCE	**±15%**
LAW ACCURACY	**0.5% peak to peak**
MAX. WORKING VOLTS, SPINDLE/ TRACK	**1,000 V.D.C.**
MAX. STARTING TORQUE ...	**8 oz/in**

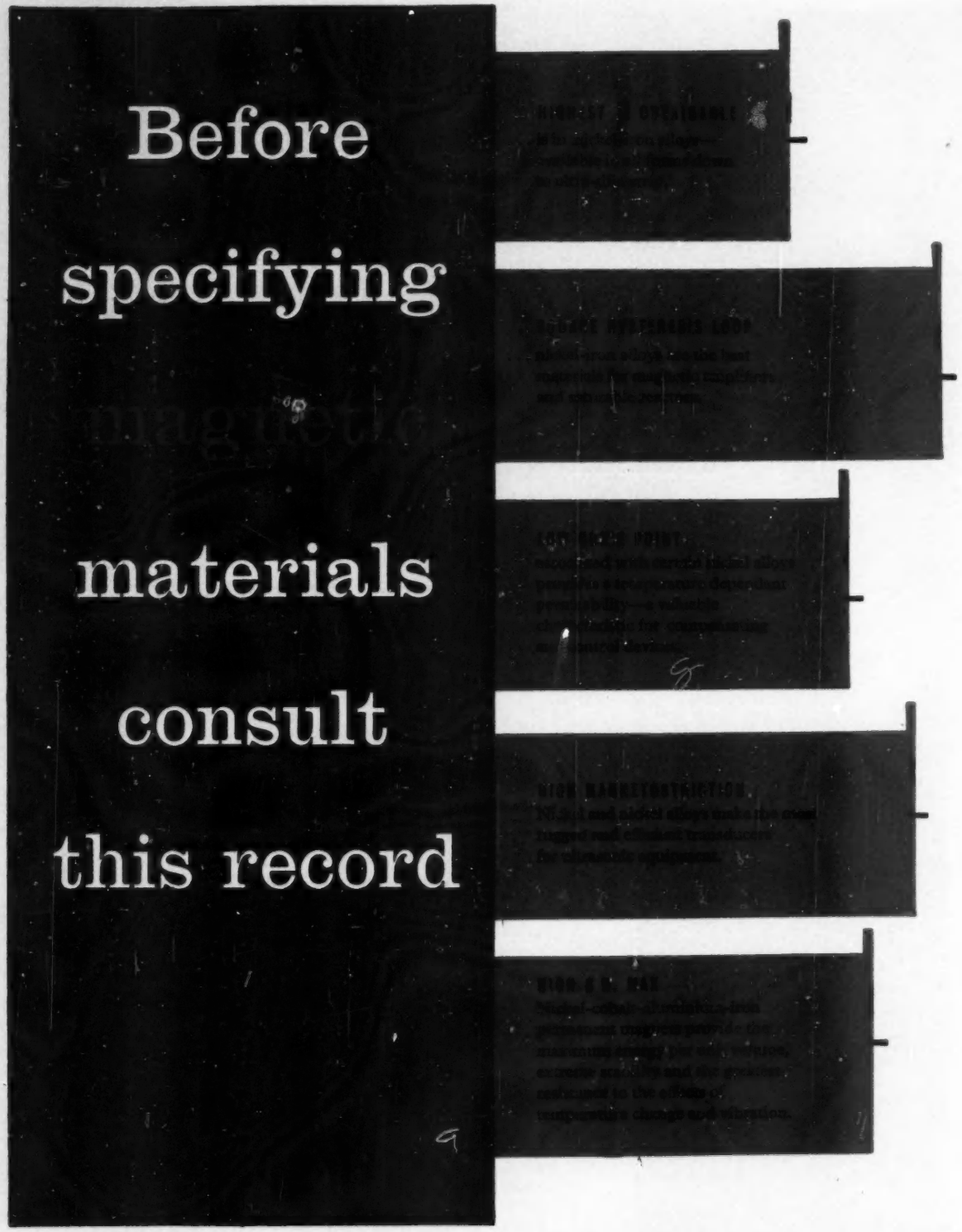
Expert advice on your particular problem from:

COLVERN Ltd., Spring Gdns., Romford, Essex, England

Tel: Romford 62222 PBX

Telegrams and Cables: COLVERN PHONE ROMFORD.

EE 40 199 *for further details*



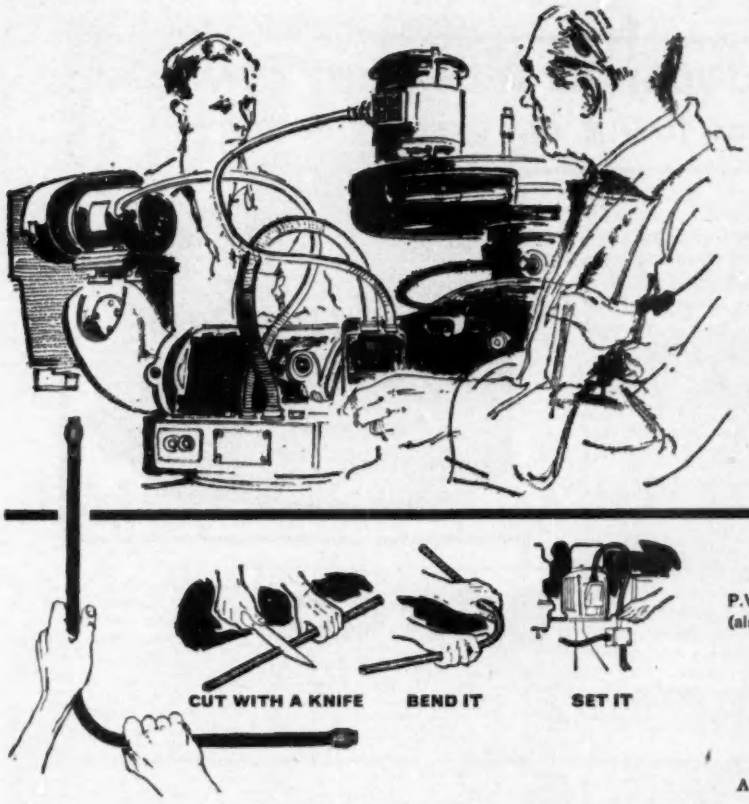
Design with Nickel-containing MAGNETIC MATERIALS

Send for a free publication 'Nickel-containing Magnetic Materials'

THE INTERNATIONAL NICKEL COMPANY (MOND) LIMITED THAMES HOUSE MILLBANK LONDON SW1

TGA 6N40

EE 40 200 *for further details*



"Done already, Dick?"

"Yes . . . wiring doesn't take long with Kopex, you know. Ever seen it? Look. It's pliable. Just cut it, bend it and fix it. Marvellous."
Kopex Pliable Electrical Conduit. A significant advance in electrical wiring installations. Easily bent by hand, remains rigid after bending and can be shaped to any radius without distorting the bore. P.V.C. covered for protection against oil, corrosion and suds. Ideal for wiring machine tools and special purpose machinery in factories and chemical plants, etc.
Kopex couplings are made in a variety of metals, and can be used with any standard electrical fittings, to make a rigid, permanent joint. Full technical information and prices on request.

KOPEX

P.V.C. covered **PLIABLE ELECTRICAL CONDUIT**
(also available without P.V.C. covering)

UNI-TUBES LIMITED
Head Office: 197 Knightsbridge, London, S.W.7
Tel: KNightsbridge 7811/5
Works: Alpha Street, Slough, Bucks.
Tel: SLough 25476/8

A member of **SMITHS** Group of Companies

SPECIAL ANNOUNCEMENT

TRIPLETONE MANF. CO. LTD.

would like to inform all companies who are interested in saving money, that they can now undertake a certain amount of extra electronic equipment production for those firms who have marvelled at the

QUALITY OF TRIPLETONES
VERY REASONABLY PRICED
HI-FI AMPLIFIERS

Several firms are benefiting from our skilled production
ARE YOU?

ENQUIRE TODAY • CAPACITY IS LIMITED
DEMAND IS HIGH

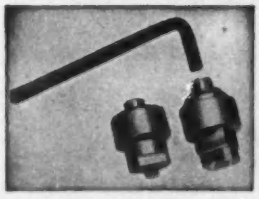
Remember, we will do the metal work as well

THE TRIPLETONE MANF. CO. LTD.
241A The Broadway, Wimbledon,
London, SW.19

Phone: LIBerty 1189

EE 40 201 *for further details*

"Q-MAX" SHEET METAL PUNCHES

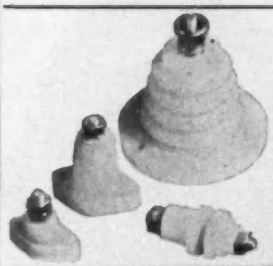


TWO NEW SIZES

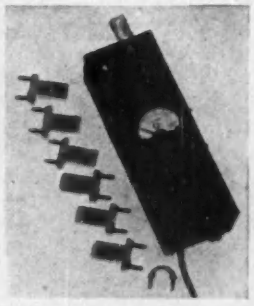
1 ¼ in.	16/6
1 ⅝ in.	18/6

(Keys 1/6 each)

LIST OF ALL SIZES AND PRICES ON APPLICATION



"Q-MAX" MODEL G.D.O.-2 GRID DIP OSCILLATOR



An ideal instrument for the determination of tuned circuit resonant frequency, tuning transmitters without application of power, for the determination of coil mutual and stray inductances and both fixed and stray capacitances. Covers 1.5 to 300 Mc/s in eight ranges. Built in mains pack.
PRICE 15 Gns. Complete

"POLYMAX" THE UNBREAKABLE INSULATOR

Stand-offs ¼", 9d.; 1" 1/-.; 1½" 1/3	
Beehive Insulators	1½" 2/6
Feed-through	2/6

Fully illustrated CATALOGUE available on request

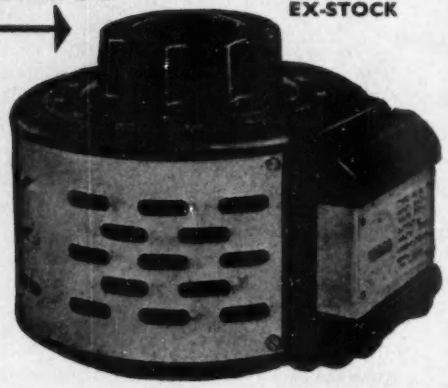
BERRY'S RADIO
25 HIGH HOLBORN, LONDON, W.C.1
Tel.: HOLborn 6231/2

EE 40 202 *for further details*

EE 40 203 *for further details*

A UNIVERSAL A.C. VOLTAGE & CURRENT CONTROL
. . . with universal fixing centres

Delivered EX-STOCK



For the most up-to-date variable transformers . . . for early delivery, too, the obvious choice is the Berco Rotary Regavolt, model 42A, rated at 580 V.A. With a maximum input voltage of 250 V. it will supply a variable output from 0-270 V. Moderately priced at £7.0.9*d.* (skeleton type) and £8.5.11*d.* (protected type as illustrated) the Berco Rotary Regavolt represents the finest value today at the lowest cost.

- **CONSTRUCTION:** Toroidally wound auto-transformers, with tracks formed on one face of the windings.
- **CORE:** Wound from a continuous strip of low loss electrical steel in a similar manner to the well-known C core construction.
- **INSULATION:** Specially processed plastic mouldings ensure minimum shrinkage due to heat and continuous use, and prevent any possibility of the turns slackening.
- **WINDING:** Of high conductivity copper, insulated with a synthetic enamel of the polyvinal acetal-phenal formaldehyde resin type, giving good space factor, exceptionally high abrasion resistance and prolonged heating resistance.
- **FRAME:** Of die cast aluminium, incorporating long spindle bearings and mounting feet to ensure accuracy and rigidity of the mechanism in relation to the fixing holes.
- **BRUSHES:** The brushes are of a special carbon for its contact resistance characteristics, shaped to give minimum loss, maximum strength and longest life.

BERCO

* *Write for list 615A giving full technical details of this and other models in the Rotary Regavolt range.*

THE BRITISH ELECTRIC RESISTANCE CO. LTD.,
QUEENSWAY, MIDDLESEX
Telephone: HOWard 2411 Telegrams: Vitrohm, Enfield
Specialists in the control of current and voltage for more than 25 years

BRI341-BXH

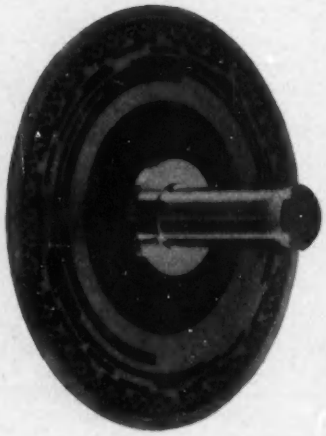
instrument engineering versatility at

DAVALL
GREENFORD MIDDLESEX

means for example—

FLUSH-BONDED SWITCH PLATES

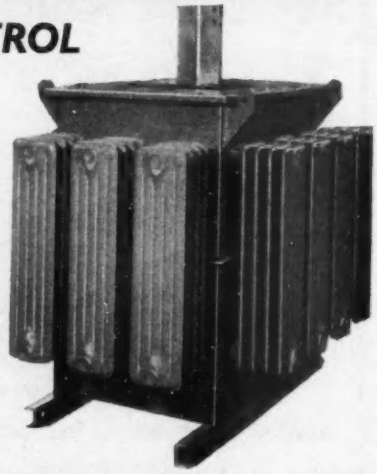
—designed and manufactured for every conceivable application. 'Phone (ALPerton 1011) for descriptive literature, or for discussions with our Engineer Specialists



EE 40 204 *for further details*

Sturdy POWER TRANSDUCTORS

For CONTROL of A.C. up to 750 KVA



1-phase 300 KVA (2000A) Transductor

For details of TRANSDUCTORS also TRANSFORMERS (up to 250 KVA) and other products in our range write to :

STURDY ELECTRIC CO. LTD.
HAMSTERLEY COLLIERY, NEWCASTLE UPON TYNE
Telephone: Ebchester 271-272 Telegrams: Sturditran, Newcastle upon Tyne

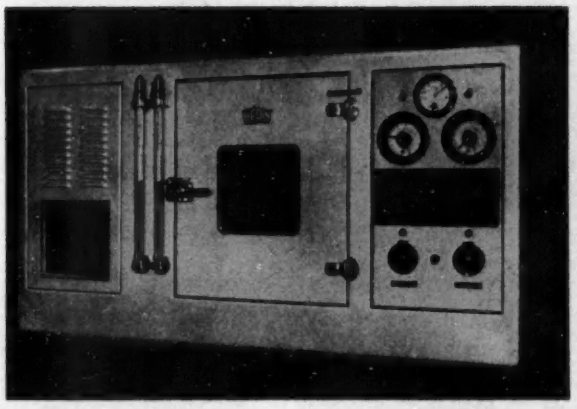
EE 40 205 *for further details*

EE 40 206 for further details

HEDIN

HUMIDITY CABINETS

Ministry Approved for Climatic Testing



Catalogue No. 755 R Humidity Cabinet with automatic control and refrigeration.

Hedin Humidity Cabinets have been Ministry approved for both RCS11 and K114 specifications, and are available for (1) climatic testing of electrical and electronic equipment; (2) durability testing of plastics, rubber, paper, chemicals, containers, confectionery and protective coatings.

- ★ Construction is of stainless steel and aluminium
- ★ Automatic control
- ★ Standard range of sizes 18″ × 18″ × 17″ to 6′ × 6′ × 6′
- ★ Refrigeration available on all models
- ★ Non-standard units to special requirements
- ★ Designed for easy maintenance
- ★ Comprehensive auxiliary equipment available

We shall be glad to demonstrate a cabinet in our works, or send you our leaflet L. 12

HEDIN LTD. Fowler Road, Hainault, Essex.
Tel.: HAinault 3031
WORKS: SOUTH WOODFORD & HAINAULT, ESSEX.

EE 40 207 for further details

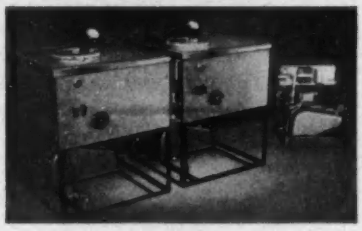
High Vacuum Systems by

BIR-VAC LTD.

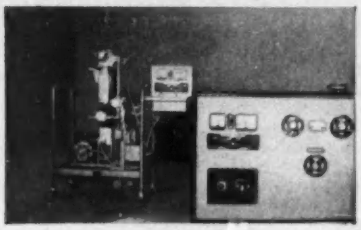
HIGH VACUUM ENGINEERS
No. 3 FACTORY
PERSHORE TRADING ESTATE
PERSHORE, WORCS.

HIGH VACUUM OVENS
Ultimate Vacuum 10-5 Torr
Temperatures up to 400°C.
Stainless Steel Chamber
Internal Heating
Temperature Measurement and Control
Fully valved and protected High Vacuum System

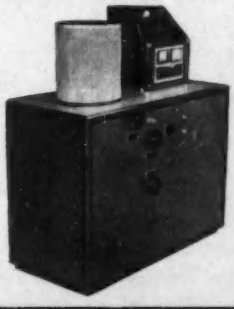
Special Systems built to customers' requirements



Resin Impregnation Equipment



Cabinet and Trolley Mounted High Vacuum Systems



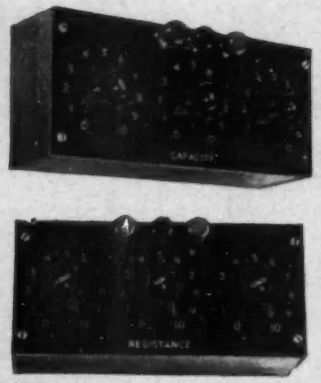
Vacuum Evaporation Plant

Full Servicing and Leak Testing Facilities

STOCKISTS FOR 'SPEEDIVAC' VIA-VAC | Genevac & Kinney

EE 40 208 *for further details*

WINSTON INSTRUMENTS FOR *Precision* WITH *Economy*



DECADE BOXES *(above right)*

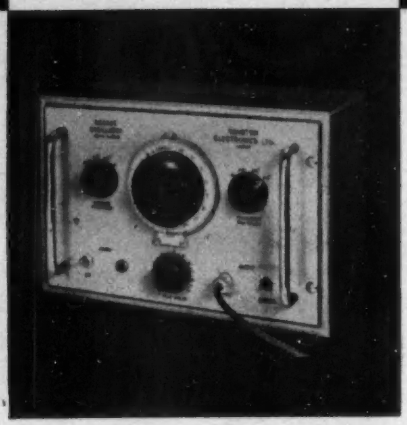
Designed to ascertain the required value of a condenser or resistance in a part of a circuit (and to overcome the necessity of expensive equipment of the 1 per cent variety when using decades for normal test functions). Valuable for use in work where a widely variable capacitor or resistance of accurately known value is required for D.C. and audio-frequency use.

Decade Resistor Boxes £13 13 0d.
Decade Capacitor Boxes £11 11 0d.

SEMI-DECADE OSCILLATOR *(right)*

The oscillator uses an R.C. Wien bridge circuit with a thermistor controlling amplitude stability. It produces independent sine and square wave outputs. Frequency range is 10 c.s. to 100 Kcs. in four main ranges with slow-motion vernier dial for setting a continuously variable frequency within the main ranges. The dial is engraved with both direct reading and vernier, for more accurate resetting. Calibration accuracy 1 per cent.

£37 10 0d.



WINSTON PORTABLE TRIGGER GENERATOR Type M640

The M640 fulfills a need in the laboratory and in the field for a compact, inexpensive and portable pulse generator capable of delivering relatively fast, high voltage triggering pulses from a low source impedance. Generators in this class are usually costly, bulky and power consuming.

£39 10 0d.

Literature supplied on request from Dept. E.E.

WINSTON ELECTRONICS LIMITED

GOVETT AVENUE, SHEPPERTON, MIDDX.

Telephone: Walton-on-Thames 26321/8

---

solenoid users . . .

KUHNKE

ROTARY SOLENOIDS

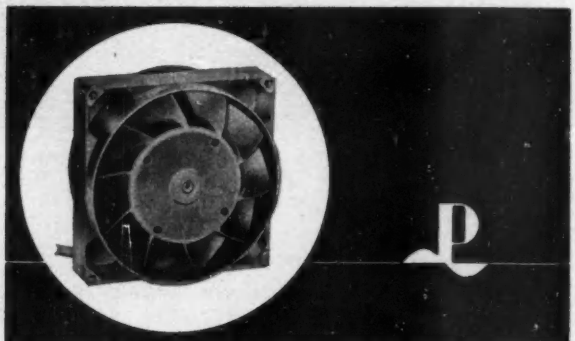
Produces up to 95° Shaft Rotation
NO axial stroke
Small size
High Torque

Write for details stating operating performance required

H. KUHNKE LTD.

163 Stanwell Road, Ashford, Middx. Tel.: Ashford 2798. Telex 21577

EE 40 209 *for further details*



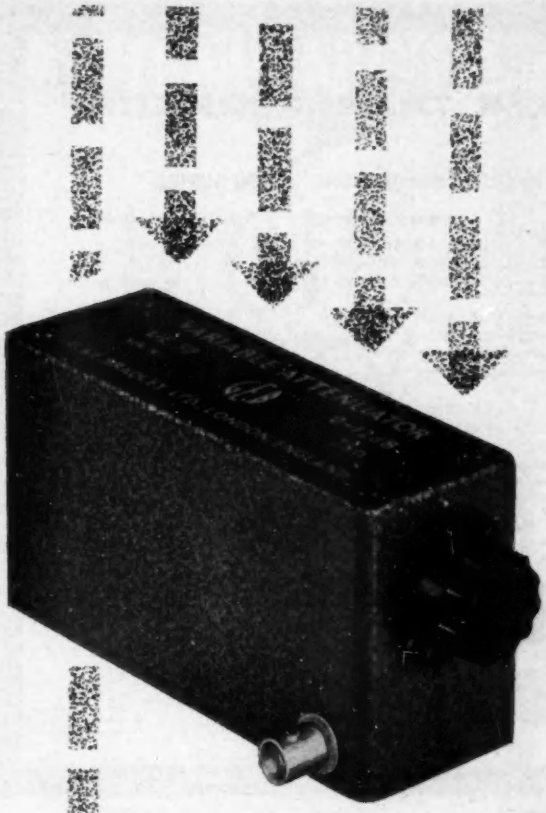
PAPST-FAN AHV 110

HIGH EFFICIENCY FAN FOR COOLING ELECTRONIC UNITS, MEASURING INSTRUMENTS, AND OTHER DEVICES.

PAPST-MOTOREN KG
(17b) ST.GEORGEN/SCHWARZWALD
WEST GERMANY

EE 40 210 *for further details*

EE 40 211 *for further details*



Variable Attenuators

G. &. E. Bradley Variable Attenuators are suitable for operation from d.c. to over 400 Mc/s. They are made in 50 and 75 ohm impedances, in ranges of 0—12 dB in 1 dB steps and 0—120 dB in 10 dB steps, with excellent long-term stability.

The 0—120 dB attenuators dissipate a maximum average power of 0.5 watt and will tolerate peak voltages of up to 350V. The 0—12 dB attenuators have a power rating of 1.5 watts and voltage rating of 350V.

On the high and low range attenuators, the B.N.C. connectors are so located that they may be directly paired to obtain a range of 132 dB in 1 dB steps.

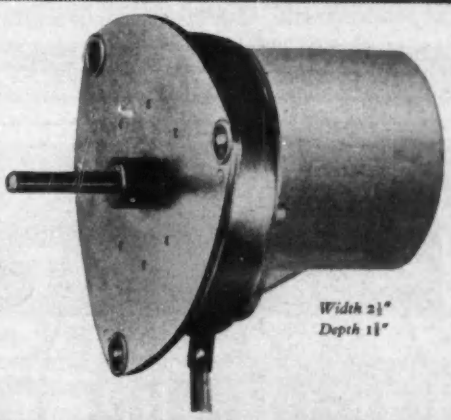
Write now for full technical data to:

G. & E. BRADLEY LTD.

Electral House, Neasden Lane, London, N.W.10
Telephone: Dollis Hill 7811
Telegrams: Bradelec—London—N.W.10

EE 40 212 *for further details*

SMITHS for Constant Speed Timing Motors



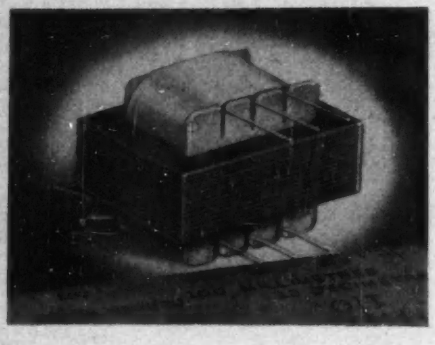
Width 2¼"
Depth 1¼"

What are *your* Timing Motor needs? Wide choice of speeds? Versatility in use? High quality? Long life? Reliability? Right price? Then choose a Smith's 'Sectric' unit—self-starting, slow speed (200 R.P.M.) permanent magnet rotors with saturated oil retaining bearings fed from supplementary reservoirs, and robust machine cut reduction gears in dust resistant housings. Smiths Constant Speed Timing Motors are C.S.A. approved, flash tested, and made by SMITHS—the name with a world of meaning. *Write or telephone now for full details and any special information you require.*

SMITHS CLOCK & WATCH DIVISION

Contracts Branch: 179 Great Portland Street, W1 *Telephone:* LANgham 5811
Overseas enquiries to Sectric House, London, NW2, England *Telephone:* GLAdstone 6464

* New MINIATURE POWER TRANSFORMERS



✳ New design of miniature power transformers suitable for 50 c/s and other power frequencies.

Range of standard specifications also special transformers to order.

Phone ELGar 5925

Typical Specification **D8000 SERIES**

Code	Primary winding	Secondary winding
D8010/W	0-220-240 volts 50 c/s	6 volts 200 milliamps.
D8011/W	0-220-240 volts 50 c/s	12 volts 100 milliamps.
D8012/W	0-220-240 volts 50 c/s	24 volts 50 milliamps.

Typical power output	1.2 VA at 50 c/s.
Insulation resistance:	
Between windings .. .. .. }	Greater than 100 MΩ
Between windings and core .. .. }	at 500v DC
Flash test at	1,500v DC
No load to full load voltage regulation of secondary	Approximately 18%.
Efficiency	Approximately 60%.
Temperature rise of winding at full load	25° C.
Weight (maximum)	2.8 oz., 80 g.

full technical data on request

ARDENTE

One of the EMI group of companies

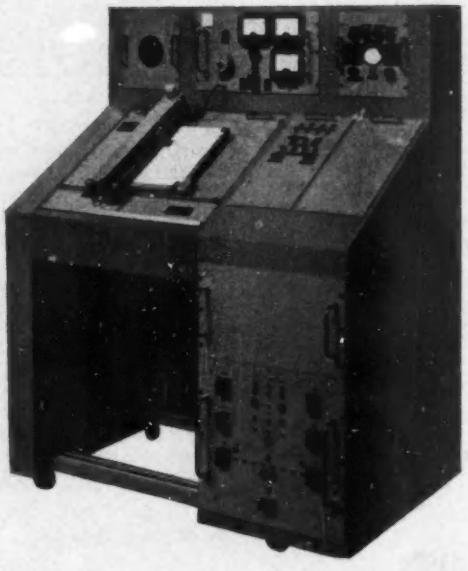
8-12 Minerva Road · North Acton · NW10

ARDENTE

ALLSCOTT

antenna radiation pattern recorder

Type 245



This new chart plotter can, in a matter of seconds, be set up for charting antenna characteristics in either Polar or Cartesian co-ordinates.

Compared to point-by-point manual methods, much time and effort is saved, and the records obtained are accurate, complete permanent and easily duplicated. The equipment operates with a 45 Mc/s IF system and is supplied with interchangeable R.F. units. Threshold sensitivity at X-band is approximately 10^{-13}W.

James Scott ELECTRONIC ENGINEERING Ltd

68 Brockville Street, Carntyne Industrial Estate, Glasgow, Scotland. Telephone: Shettleston 4206

EE 40 215 *for further details*

COMINCO

HIGH PURITY METALS

ARSENIC

This very pure arsenic is available to the electronics industry as COMINCO 69 GRADE. It is ideal for use in compound semi-conductors and is available in the form of dense crystalline pieces of random size generally less than 2 cm. sq. by 0.5 mm. thick. The product is available in 25,50 and 100-gram lots vacuum sealed in pyrex ampoules. Ampoules containing specific quantities can be supplied on request. Elements detected spectrographically total 1 to 2 ppm. and sulphur content is less than 0.1 ppm.

69 GRADE ARSENIC is one of a number of pure metals produced by the CONSOLIDATED MINING AND SMELTING COMPANY OF CANADA LTD., to meet the exacting requirements of the semi-conductor industry. Other pure metals available include Antimony, Bismuth, Cadmium, Indium, Lead, Silver, Tin and Zinc.

Available in the United Kingdom and Europe from:

HENRY GARDNER & COMPANY LIMITED

2, METAL EXCHANGE BUILDINGS, LEADENHALL AVENUE, LONDON, E.C.3.
Telephone: MANsion House 4521. Telex: LONDON 28547.

Henry Gardner & Co. Ltd., offer full technical services, supported by the Research Division of the producers.

METWAY
TERMINAL BLOCKS

For full details ask for Cat. No. NBG/OHS/EG

METWAY · KEMP TOWN · BRIGHTON 7

EE 40 216 *for further details*

Today's best value in heavy gauge **STEEL SHELVING**

£3·15·0
DELIVERED FREE!

- Brand new — Manufactured in our works.
- Shelves adjustable every inch.
- Heavy gauge shelves will carry 400lb. distributed weight each.
- Stove enamelled dark green.
- 6 shelves per bay — Extra shelves 8/- each.
- Quantity discounts.
- Unassembled, ready for erection.

Free Delivery in England, Scotland and Wales.

THE ONLY HEAVY GAUGE SHELVING AT THIS PRICE

Other Sizes available · Also available in white at £5 per bay.

N. C. BROWN LTD. EQUIPMENT WING HEYWOOD, LANCS. *Tel.* 69018 (6 lines)

EE 40 217 *for further details*

EE 40 218 for further details

NEW APM ONE OUNCE

Vertical injection moulding machine

APM 25 range of automatic or hand operated machines

Available in four versions, two fully automatic models powered either by hydraulic or pneumatic units, one hand operated model and one semi-automatic hydraulic machine.
All models are available with interchangeable cylinders of four different bores, are fitted with contact thermometer controls and are capable of fast cycling when desired.

Other popular machines in the APM range include:

APM 28 1½ oz. max. shot, hydraulically operated with improved heating control and operation.

APM 22 ¾ oz. max. shot, hand operated Bench machine.

★ HYDRAULICALLY OPERATED MODEL

FULLY AUTOMATIC

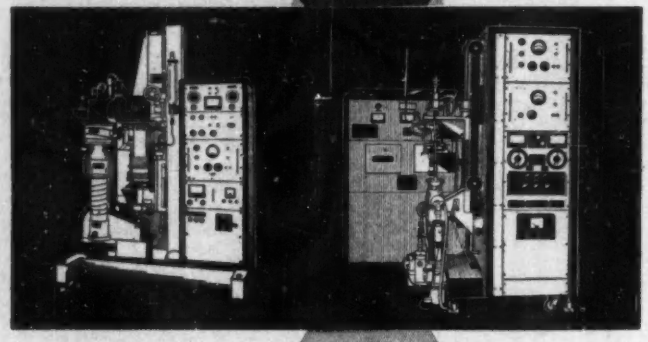
FAST CYCLING

INTERCHANGEABLE CYLINDERS

ASMIDAR PLASTIC MOULDING MACHINES LTD., 10, Tachbrook Street, London, S.W.1. England. Telephone: VICtoria 5554

RADYNE
REGISTERED TRADE MARK

AHEAD IN SEMI-CONDUCTORS



A RADYNE V.C.P.2 crystal puller powered by a 15/25kW generator and gas refiner. This is one of 5 units which may be modified to suit individual customer's requirements.

A RADYNE silicon zone refining unit coupled with a RADYNE 15kW 4 Mc/s R.F. generator.

across new frontiers

FLOATING ZONE REFINING

An application of radio frequency heating to the purification of germanium, silicon, and other materials. By traversing a molten zone from one end of the ingot to another, impurities are concentrated at one end.
Two RADYNE equipments are available —a quartz tube gas refiner and a vacuum chamber unit.

CRYSTAL PULLING

RADYNE equipment for preparing mono-crystalline germanium, silicon, and other materials includes the G.C.P.2 gas crystal puller and the V.C.P.2 vacuum or gas crystal puller, based on the Czochralski technique.
Maximum charge is 950 gm. of germanium; 400 gm. of silicon.
RADYNE units are especially easy to load and unload, and to clean; components with wide margins of strength and power guarantee reliability.

RADYNE LTD

WOKINGHAM BERKS ENGLAND Telephone: Wokingham 1030 Telegrams: Radyne England

P6309

EE 40 219 for further details

EE 40 220 *for further details*

IN PARIS PORTE DE VERSAILLES

FROM **16TH** TO **20TH FEBRUARY 1962**

5th INTERNATIONAL EXHIBITION OF ELECTRONIC COMPONENTS

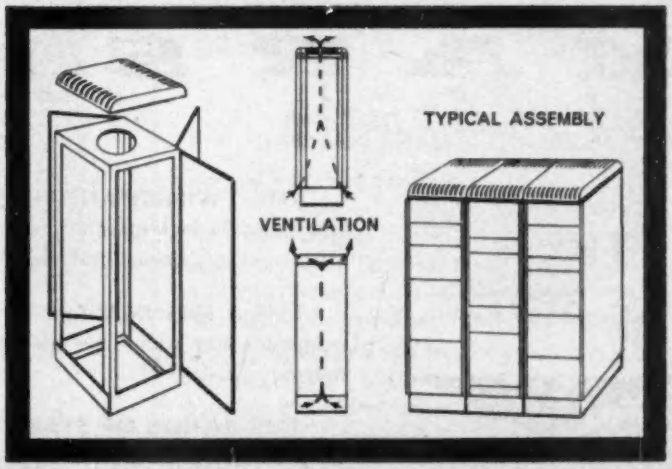
The greatest world meeting in the field of electronics

FÉDÉRATION NATIONALE DES INDUSTRIES ÉLECTRONIQUES

23, rue de Lübeck - PARIS-16e Passy 01-16

PUBLI-SERVICE • PARIS

Instrument racks off the peg!



HIGH QUALITY STANDARD RACKS AT REALLY ECONOMICAL COST

Standard Instrument racks are a Ritherdon speciality. The standard Racks offered by Ritherdon have been designed to satisfy the demand for a really high quality rack at a competitive price. Available in three heights: 4 ft., 5 ft., and 6 ft., and in two basic widths to take 19 in. or 22 in. standard panels, the racks are made for use either individually or to be built up into complete bays. Manufactured from bright mild steel, 1½ in. by 1½ in. by ⅛ in. angle and best strip mill 18s gauge steel sheet, the racks are tapped with standard 1½ in. and ½ in. spacing. Ventilation also has been carefully considered with grills in the top (front and back), while provision is made for top fan mounting if necessary.

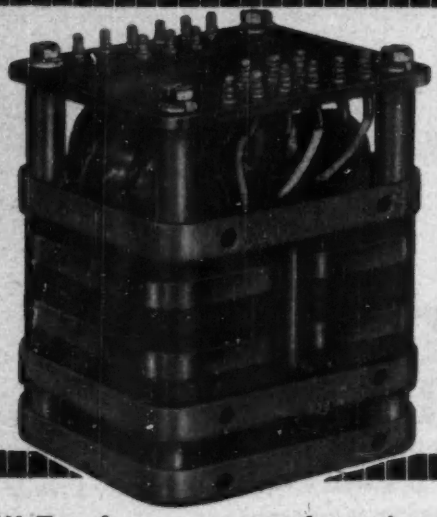
Full details and prices for any quantity of these racks, together with panels, chassis and chassis runners, are immediately available on request. For special heights, finishes, dustproofing, and provision for internal panel mounting etc., quotes will be supplied without delay.

Write or telephone for complete details

RITHERDON & CO. LTD.

DARWEN LANCS. TEL: DARWEN 1028

EE 40 221 *for further details*



High Quality—
Quick Delivery—
Low Cost—
TRANSFORMERS

A.R.W. Transformers are manufactured to the highest standard and provide reliable long life service. Up to date facilities under modern factory conditions ensure competitive prices and quick deliveries. Facilities are available for the design and development of special types.

- **TRANSFORMERS AND COILS FOR ELECTRONICS**
- **POWER TRANSFORMERS**
- **PORTABLE TRANSFORMERS**
- **"C" CORE TRANSFORMERS AND CHOKES**
- **PULSE TRANSFORMERS**
- **SWITCHGEAR TRANSFORMERS AND COILS**

Write or telephone for illustrated leaflet

ATKINS ROBERTSON & WHITEFORD LTD

Industrial Estate · Thornliebank · Glasgow *Telephone: GIFFNOCK 1031*

MARSHALL

THE BEST, FOR YOU

THE TWIN-CHANNEL PULSE GENERATOR Type 102 is a superb instrument for high speed/high precision work, while the **Type 100** is a fully reliable instrument to a less ambitious specification.

THE 1 Mc/s SCALER Type 200 is designed for reliability, using a novel (patented) ring circuit for transistors and a neat arrangement of printed circuit boards.

THE RANGE OF STABILISED TRANSISTOR POWER SUPPLIES is designed around transistors to bring you the best in design, performance, serviceability and finish—at very competitive prices.

All are made by the Makers of the well-known
MARSHALL PULSE HEIGHT ANALYSER
which is in use in 16 countries.

Enquiries to Sales Department

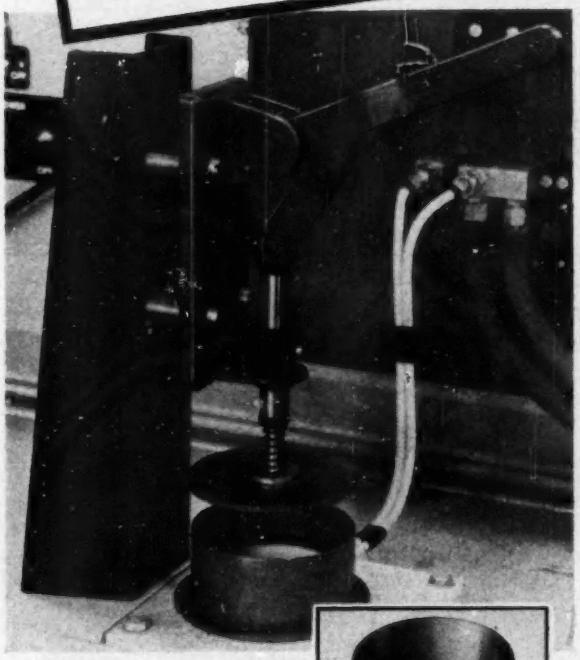
MARSHALL OF CAMBRIDGE ELECTRONICS LIMITED
THE AIRPORT, CAMBRIDGE, ENGLAND

EE 40 224 *for further details*

BRAUER 'Quick-Action' TOGGLE CLAMPS

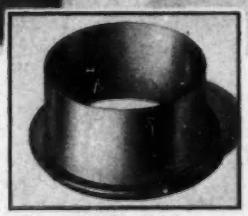
for the Electronics Industry can be made in special Non-Ferrous Non-Magnetic materials. Wherever used, BRAUER TOGGLE CLAMPS save thousands of man hours with their fast, powerful and accurate holding.

FOR QUICKNESS AND POWER USE CLAMPS BY BRAUER



BRAZING

The illustration shows a BRAUER 'Quick-Action' TOGGLE CLAMP Type TC.62 being used to meet the requirements of efficient induction brazing–quick positive clamping and instant releasing at Radio Heaters Ltd., Wokingham.



This brazing fixture incorporating a BRAUER Clamp has achieved considerable saving of time and money in the production of meter cases (see inset photograph).

Send now for illustrated catalogue and technical data to Dept. 14

F. BRAUER LTD., Harpenden, Herts.

TELEPHONE: HARPENDEN 3603

Member of the Cope Allman Group

Makers of Europe's largest range of Toggle Clamps

FWB

EE 40 225 *for further details*

Wilkinsons EST. 1921

NEW STOCKS OF METERS

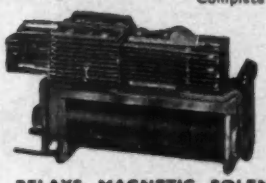
A.C. RECTIFIER TYPE 3½" Moving Coil Flush Round MICROAMMETERS & VOLTMETERS

Selection from our other stocks

2½" Moving Coil Flush Round
0/1 amp; 0/3 amp; 0/5 amp; 0/10 amp; 0/20 Volts; 0/30 Volts; 0/40 Volts; all at 35/- each.

2" Moving Coil Flush Round
0/1 Milliamp; 0/5 Milliamp; 0/10 Milliamp; 0/20 Volts; 0/30 Volts; 0/40 Volts; all at 27/6 each.

2" Moving Coil Flush Square
0/3 Ampere; 0/5 Ampere; both at 27/6 each. and 0/1 Milliamp at 37/6. Postage on meters 2/-. Complete stock list available.



RELAYS

Post Office Type 3000
Made to your specification.
Contacts up to 8 C.O.

Prompt Delivery

RELAYS MAGNETIC SOLENOID OPERATED. 24 volts D.C. 4 Make and 4 Break 10 amp contacts 5C/3944. Brand new complete with dust cover. 12/6 each, post 2/-.

KEY SWITCHES
Various P.O. types
EX. STOCK

High Speed Miniature Sealed Relays— G.E.C., S.T.C. and Siemens

ELECTRO MAGNETIC COUNTERS—HIGH SPEED TYPE. Counting up to 9999. 1 in. by 1 in. by 3½ in. operating from 100-120 volts D.C. 2300 ohms. Type 100B 35/- each, post 2/-.

L. WILKINSON (CROYDON) LTD.
19 LANSDOWNE RD. CROYDON SURREY
Phone: CRO 0839 Grams: WILCO CROYDON

micro-electric

Precision miniature components for electronic equipment

Cristal Microphones
Miniature Volume Controls and Switches
Small Transformers and Toroidal Transformers
Plug Sockets for miniature tubes and transistors

Write for catalogue and information

MICRO-ELECTRIC LTD. — Zurich 52 — Switzerland

EE 40 226 *for further details*

Q.C.C.

YOU are invited to apply for a copy of our latest illustrated brochure and price list which gives full details of our wide range of

QUARTZ CRYSTAL UNITS

which are renowned for their

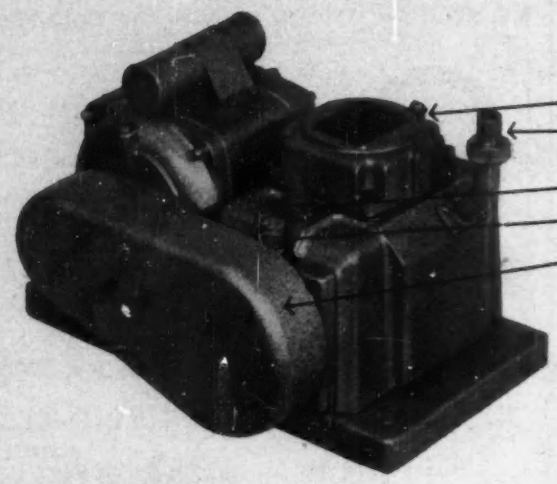
Accuracy & Reliability

THE QUARTZ CRYSTAL Company Ltd.
Q.C.C. Works, Wellington Crescent, New Malden, Surrey
Telephones: MALden 0334 & 2988 Grams & Cables: Quartzco, New Malden

EE 40 227 *for further details*

Whatever you need in a VACUUM PUMP –

N.G.N. PROVIDE IT



Automatic Oil Emptying
Demountable Vacuum Connection to suit tube to B.S.S. 659
Oil level sight glass
Full variable gas ballast control on all pumps
Cast Belt Guard
Non-Return Valves for all sizes

N.G.N. Rotary Piston Pumps are of radically different design protected by patents in all major countries.

TYPE	No. of Stages	SPEED		ULTIMATE VACUUM (McLeod)	
		cu.ft/min	litres/min	Without Ballast	With Ballast
PSR 1	1	1	28	·005 TORR	0·5–1·0 TORR
PSR 2	1	2	56	·005 ,,	,,
PSR 3	1	3	84	·005 ,,	,,
PSR 6	1	6	168	·005 ,,	,,
PSR 12	1	12	336	·005 ,,	,,
PD 1	2	1	28	·0001 ,,	< ·001 TORR
PD 3	2	3	84	·0001 ,,	< ·001 ,,
PD 6	2	6	168	·0001 ,,	< ·001 ,,

Pumps of larger capacity are being developed

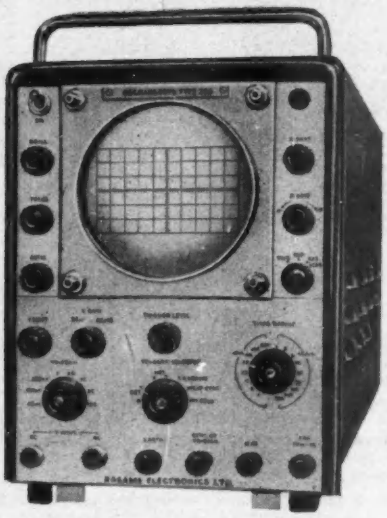
The inter-connection of stages on the PD range of pumps employs an entirely new principle resulting in exceptional gas ballast performance.

N.G.N. ELECTRICAL LTD.
Church Bank Works, Church, Lancs. Tel: Accrington 35611

ACCURATE LABORATORY MEASURING OSCILLOSCOPE

2% ACCURACY

5" dia. precision flat face C.R.T. with P.D.A.
Y Amplifier D.C. to 11 Mc/s. (-3dB). Rise Time: .035 μS. 25 mV/cm to 100 V/cm. Constant Bandwidth
Internal pre-amp. gives 2.5 mV/cm. (3 c/s to 750 Kc/s.–3dB).
Sweep Speed: 0.05 μS/cm. to 0.2 sec/cm.
(X amp. at x10). (X amp. at x1)
X amp.
Gain control x1 to x10.
H.T. and E.H.T. supplies stabilised.
D.C. coupled bright-up pulse to C.R.T.
3.5. K.V. E.H.T.
Versatile triggering circuit. ±ext. trig. ±int. trig.
T.V. frame. H.F. synch. int. 50 c/s.
Anti-parallax graticule.
Designed for Pulse or Sine wave measurements.
Mains 90/140V. 200/240V.



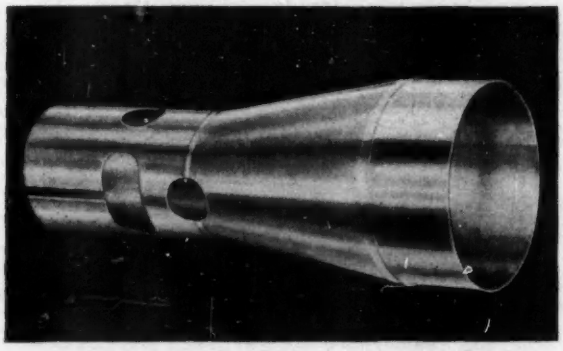
KASAMA ELECTRONICS LTD

139-149 FONTHILL ROAD, FINSBURY PARK, LONDON, N.4.
Telephone: ARCHway 6160

EE 40 230 *for further details*

Capstan and Automatic Work and Sheet Metal Pressings in any Metal, any Finish, any Quantity

GRIFFITHS GILBART LLOYD
AND COMPANY LIMITED
EMPIRE WORKS
PARK ROAD
BIRMINGHAM 18
TELEPHONE NORthern 6221



ETEL CRT 3AZP31

MUMETAL SHIELDS FOR CATHODE RAY TUBES and Instruments

✻ *Guaranteed delivery dates including overseas customers*

OLIVER & RANDALL LTD.
40 PERRY HILL · LONDON S.E.6 Tel.: BECkenham 8262
EE 40 231 *for further details*

TRANSFORMERS DESIGNED & MANUFACTURED

Prototypes or batch productions of all types up to 3KVA.
Prompt delivery. Suppliers to B.B.C./I.T.A. Universities and leading Industrial Concerns.

EST. 1922 PHONE: SHI 2483

FORREST TRANSFORMERS LTD.
SHIRLEY, SOLIHULL, WARKS.

EE 40 232 *for further details*

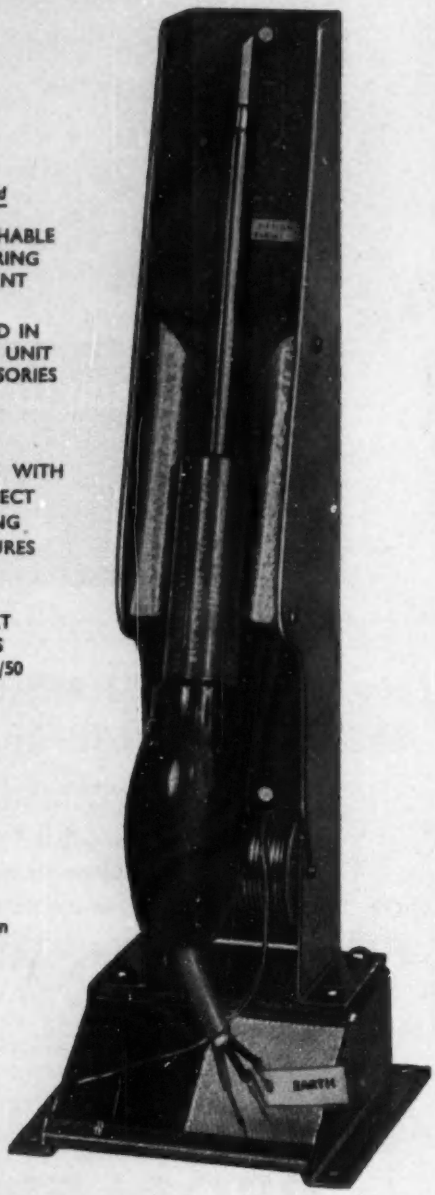
IF YOU HAVE A
FILTER DESIGN
PROBLEM
CONSULT **VECTRON**

We provide a design service for industry— Consult our experienced design staff for an active or passive solution to your filter problem.

VECTRON ELECTRO-PHYSICS LTD.
Spur Road, North Feltham Trading Estate
Bedfont, Middlesex. *Tel:* FEL 6691
EE 40 233 *for further details*

Soldering Instruments and Equipment

ADCOLA
(Reg. Trade Mark)



Illustrated

¼ in. DETACHABLE BIT SOLDERING INSTRUMENT L64
POSITIONED IN PROTECTIVE UNIT WITH ACCESSORIES L700

INSTRUMENTS WITH THE CORRECT SOLDERING TEMPERATURES

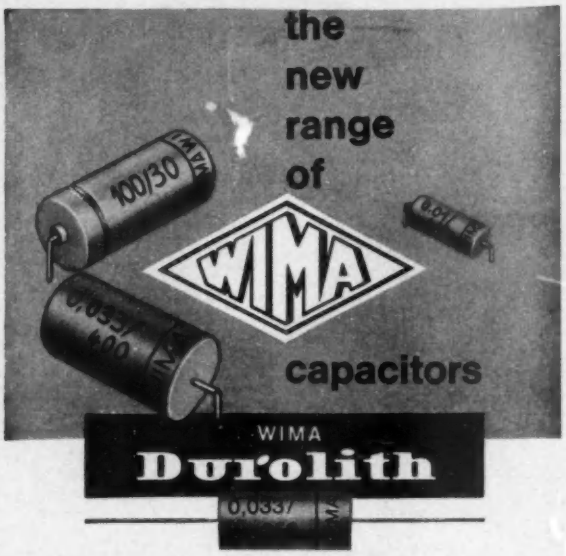
ALL VOLT RANGES 6/7 to 230/50 VOLTS

British & Foreign Pats. & Reg. designs.

For further information and full illustrated catalogue apply head office.

ADCOLA PRODUCTS LIMITED
ADCOLA HOUSE, GAUDEN ROAD, CLAPHAM LONDON, S.W.4

Telephones: MACaulay 3101 and 4272 *Telegrams: SOLJOINT LONDON S.W.4*



WIMA
Durolith
0.033/

The new resin moulded and impregnated paper—and—foil capacitors. High dielectric strength. Good ionization, and I.R. properties. Excellent A.C. characteristics. Temp. range, −55°C +100°C.

Range: 250 V. D.C./150 V. A.C. 0.01 mfd to 0.22 mfd.
400 V. D.C./250 V. A.C. 4700 pF to 0.15 mfd.
630 V. D.C./300 V. A.C. 1000 pF to 0.068 mfd.
1000 V. D.C./400 V. A.C. 1000 pF to 0.033 mfd.

WIMA
tropyfol
0.033/

Type M. Miniature metallized polyester capacitors. Safe H.F. contact with very low inductance and self healing properties. **New revised prices showing substantial reductions on many types.** Temp. range: −55°C +100°C.

Range: 125 V. D.C. 0.01 mfd to 1 mfd.
400 V. D.C. 0.01 mfd to .47 mfd.

Type F. Polyester—and—foil capacitors. Welded leads giving safe H.F. contact. Long term stability. Temp. range −55°C +100°C.

Range: 125 V. D.C. 4700 pF to 0.15 mfd.
400 V. D.C. 47 pF to 0.47 mfd.
1000 V. D.C. 4700 pF to 0.1 mfd.

WIMA
Printilyt
25/12

Miniature low voltage electrolytics; now all welded electrodes giving safe contact under low voltage and current. **Substantial price reductions over the whole range.**

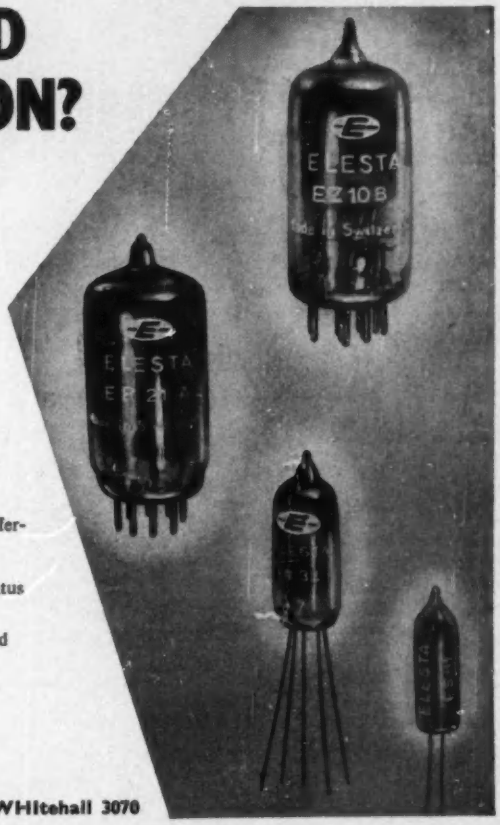
Full technical specifications and prices from Sole U.K. Agents.

WAYCOM LIMITED
CAPACITY HOUSE, ROTHSAY STREET, TOWER BRIDGE ROAD, LONDON, S.E.1.
Tel.: HOP 2615/9

EE 40 236 *for further details*

ELESTA AG BAD RAGAZ

ARE YOU INTERESTED IN AUTOMATION?



ELASTA precision cold cathode tubes with pure molybdenum cathodes are the best and most versatile electronic components for switching, timing, counting or stabilizing. They offer YOU these special advantages :—

Very precise and constant characteristics over a virtually unlimited operating life.

Always ready for instantaneous use, no heater, no warm-up time, no standby power consumption.

Rugged and particularly reliable; unaffected by current surges.

Wide range of ambient temperature: −20°C to +60°C.

Direct operation from A.C. mains or from unstabilized D.C. supplies.

Very high input impedance and current amplification of up to 10 million in one single stage.

Counting speeds up to 1 million p.p.s. and ability to stand the discharge on one cathode without deterioration of performance.

Visual as well as electrical read-out.

Very precise voltage stabilization with wide current ranges and small differences between the stabilized voltage of different tubes.

Miniaturization to comply with modern requirements.

Extremely simple circuitry enabling uncomplicated and inexpensive apparatus of high accuracy and reliability such as:

Photoelectric relay: automatic light controls; electronic timers and pilot relays; level controls; electronic counters; etc.

Write or phone NOW for practical and proven circuits and technical information:

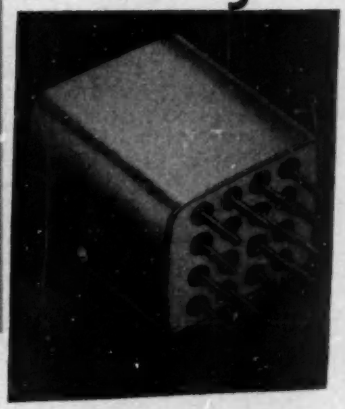
BRITEC LIMITED

17, CHARING CROSS ROAD, LONDON, W.C.2. Telephone: WHitehall 3070

ANOTHER ADDITION TO THE FORTIPHONE MINIATURE COMPONENT RANGE

NOW the 4 pole miniature G.100 relay

Dimensions	.61" x .98" x .76"
Temperature range	−65° to +125°C
Coil voltage	1·5 to 48 V
Nominal sensitivity	240 mW at 20°C
Actual sensitivity	80 mW
Contact rating	0·5A at 50 V max (will be special)
Vibration	Better than 20g from 10 to 3,500 c/s



rugged
reliable
sensitive

FOUR POLE CHANGE-OVER
BALANCED ARMATURE
TWO COMPARTMENT SEALING
ALSO TWO POLE VERSION

For further details please write to:-

COMPONENTS DIVISION
FORTIPHONE LIMITED (DEPT. R.Z) 124-6 DENMARK HILL, LONDON, S.E.5

EE 40 237 *for further details*

EE 40 238 for further details

WHY PICK ON US?

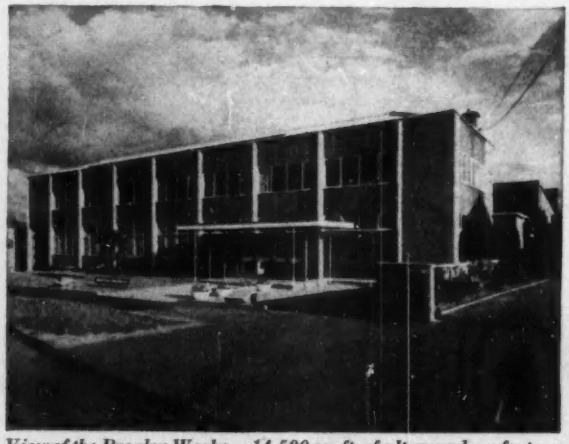
(. . . a question with many answers)

BECAUSE WE CAN HELP YOUR FORWARD PLANNING

Among the famous firms using the Broxlea Service, those that make the best use of it are those who include it in their *forward* planning. You may not need the extra electronics wiring or assembly service now, but when you make forward plans it might be useful to remember that Broxlea can often accept forward contracts for this work in which they specialise . . . so why not write Broxlea about your future plans? If you contact Leslie D. Izzard, Broxlea Planning Director, you may find that he can organise immediately work to be done for you in the future—help your forward planning.

BROXLEA SERVICE

ELECTRONIC MANUFACTURE, ASSEMBLY, WIRING, ETC.



View of the Broxlea Works—14,500 sq. ft. of ultra modern factory space, 15 miles from central London on the A10 road to Cambridge.

Trusted by the people you trust

Below are some famous names —firms who entrust work to Broxlea, and who have kindly permitted their names to appear:

Associated Electrical Industries Ltd.
Bell Punch Co. Ltd.
Brayhead Ltd.
Bristol Aircraft Ltd.
E. K. Cole Ltd.
Cossor Radar & Electronics Ltd.
Dewhurst & Partner Ltd.
Elliott Bros. (London) Ltd.
E.M.I. Electronics Ltd.
Enfield-Standard Power Cables Ltd.
English Electric Aviation Ltd.
Evershed & Vignoles Ltd.
General Electric Co. Ltd.
General Precision Systems Ltd.—Air Trainers Link Division
Ilford Ltd.
International Computers and Tabulators Ltd.
Lansing Bagnall Ltd.
Magnetic Devices Ltd.
Marconi's Wireless Telegraph Co. Ltd.
Microcell Ltd.
The National Cash Register Co. Ltd.
Pye Ltd.
A. V. Roe & Co. Ltd.
Rotax Ltd.
Sangamo Weston Ltd.
Standard Telephones & Cables Ltd.
Telephone Manufacturing Co. Ltd.
Texas Instruments Ltd.
Tube Investments (Group Services) Ltd.
Witton-James Ltd.

you will be in good company if you, too, trust Broxlea.

BROXLEA PRODUCTS LIMITED (A.I.D. approved)
BROXBOURNE, HERTS **Hoddesdon 4455**

World in a box

Touch a switch and billions of free electrons bring the world
into your home. Condensers, valves, transistors do the work.
But they have to be mounted, insulated and protected. Here Shell's TGH grade
of 'Carinex' polystyrene is ideal. Its toughness, heat resistance and good electrical properties
make a television set into a piece of furniture of which to be proud.
But television and radio cabinets' escutcheons, control panels
and speaker grilles are just a few of the applications 'Carinex' can cope with.
In all its grades, all its colours, it will suit almost any
injection moulding job you care to name.

CARINEX
POLYSTYRENE

Shell Chemicals

SHELL

Ask Shell Chemical Company Limited,
Plastics & Rubbers Division, 170 Piccadilly, London, W.1.

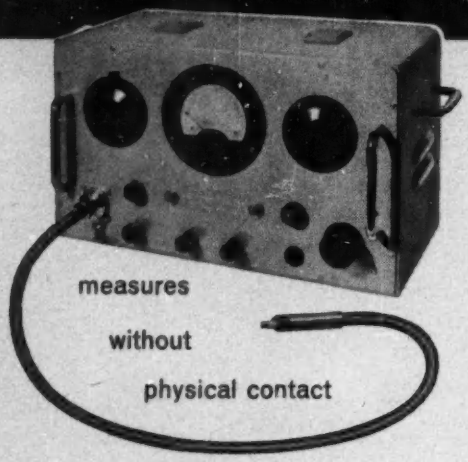
SHELL and CARINEX are Registered Trade Marks

P.S.6

EE 40 240 *for further details*

THE *Fielden* PROXIMITY METER

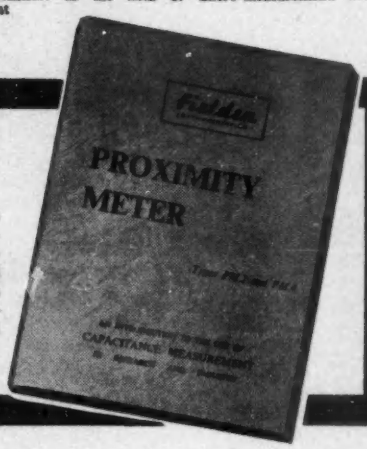
sensitive to one hundredth part of one thousandth of an inch.....



The Fielden Proximity meter is an extremely versatile instrument, enabling observations to be made in research and industry which would otherwise be impractical. It can be used as a concentricity gauge, micrometer, vibration meter, dielectric comparator and for pressure measurement, etc. Small capacitance changes due to physical displacement or dielectric change can be detected with a high degree of sensitivity, indispensable in the field of micro-measurement. No laboratory or test department should be without one.

FREE
28 PAGE BOOKLET

Write today for this informative booklet—"Capacitance Measurement in Research and Industry," Publication 225/EE, giving full application information and technical data.

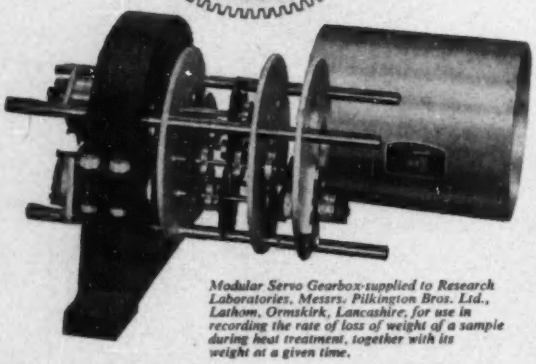


Fielden

FIELDEN ELECTRONICS LTD.: WYTHENSHAWE, MANCHESTER. Phone: Wythenshawe 3251 (6 lines) Grams: Humidity Manchester.
ALSO AUSTRALIA, ITALY, U.S.A., CANADA. *Branch Offices:* LONDON, WALSALL, STOCKTON-ON-TEES, EDINBURGH (A. R. BOLTON & CO., LTD.) AND DUBLIN
Agents throughout the world.

Indicating
Recording
Control

Modular
SERVO
Gearboxes

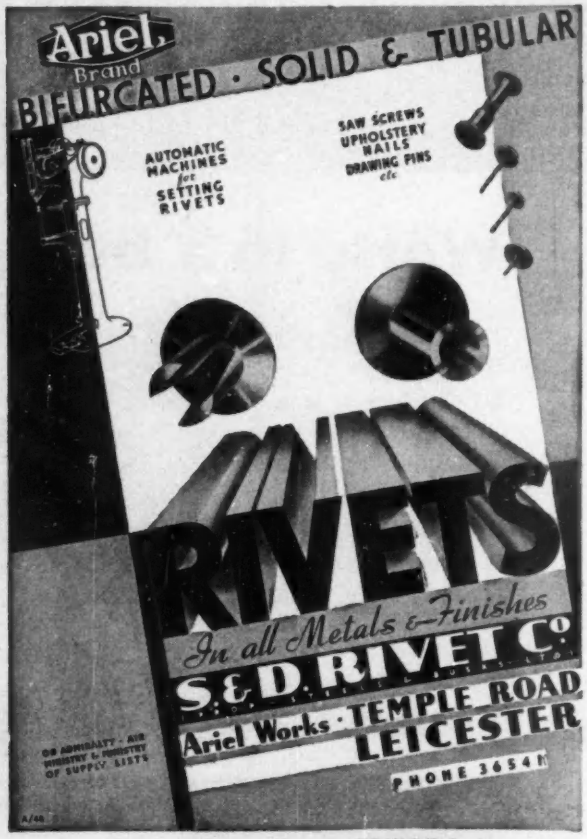


Modular Servo Gearbox supplied to Research Laboratories, Messrs. Pilkington Bros. Ltd., Lathom, Ormskirk, Lancashire, for use in recording the rate of loss of weight of a sample during heat treatment, together with its weight at a given time.

Complete mechanisms can be produced to specific requirements from standard components. Readily interchangeable gear ratios and components bring HIGHLY COMPETITIVE PRICES and quick delivery. Suitable for experimental prototype and production quantities. Gears to Admiralty Class 1, zero backlash in all ratios using spring loaded split gears, corrosion resistant throughout, ball bearings friction tested, assembly work carried out in dust-free conditions.

Write for Bulletin No. 10 to
RELIANCE GEAR COMPANY LTD.
St. Helens Gate, Almondbury, Huddersfield, Tel: 7762-3

EE 40 241 *for further details*



EE 40 242 *for further details*

EE 40 243 for further details

QUALITY SERVICE

"No Quantity Too Small"

Bronze Copper Aluminium

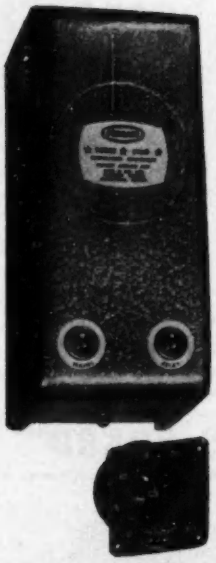
H. ROLLET & Co. Ltd.

Magnesium Brass Duralumin

Stockists since 1896

LONDON
BIRMINGHAM
LIVERPOOL
MANCHESTER
LEEDS

JEB



PERRAM

*THREE*STAR*

temperature controller

Offers you all the accuracy, flexibility and reliability of an expensive instrument—*yet costs under £35!*

For full details of this superb instrument, please write to the address below.

Yet another important achievement by

TYER

TYER & COMPANY LTD

Estd 1851

DEPT. TC · PERRAM WORKS · WEARROW SIDING · GUILDFORD · SURREY

GUILDFORD 4211

Within the organisation of the Southern Areas Electric Corporation

EE 40 244 for further details

ELECTRO-MAGNETIC COUNTERS

FOR ALL D.C. VOLTAGES

TESTED & GUARANTEED

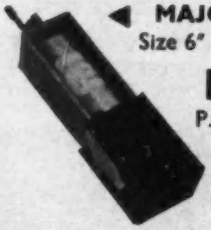
◀ MAJOR TYPE ▶

Size 6" × 1½" × 1¼"

2578

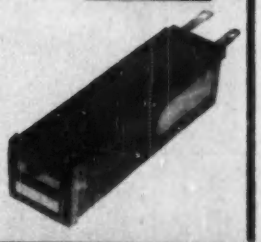
17/6

P. & P. 1/-



MINOR TYPE—HIGH SPEED ▶

Size 4" × 1" × 1" 25/- P. & P. 1/-



Jack Davis (Relays) Ltd.

(DEPT. E.) TUDOR PLACE, LONDON, W.1

TELEPHONES: MUSEUM 7960 LANGHAM 4821

Off Tottenham Court Road—Next to Woolworths.

EE 40 245 for further details

EE 40 246 *for further details*

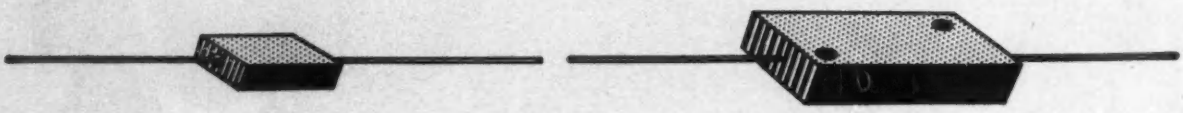
FULLY TYPE APPROVED SILVERED MICA CAPACITORS

TO RCS132 CAT. "A" CLASS H.1

Type CMM1-G
Available in preferred values from 10pF to 1500pF to tolerances of 2%, 5% and 10%. Dimensions $\frac{11}{16}$"× $\frac{7}{16}$"× $\frac{7}{16}$". Fully type approved to RCS 132 category "A" Class H.1.

types CMM1-G CMM3-Y

Type CMM3-Y
Available in preferred values from 470pF to 10,000pF to tolerances of 2%, 5% and 10%. Dimensions 1½"× $\frac{11}{16}$" × $\frac{5}{16}$". Fully type approved to RCS 132 category "A" Class H.1.

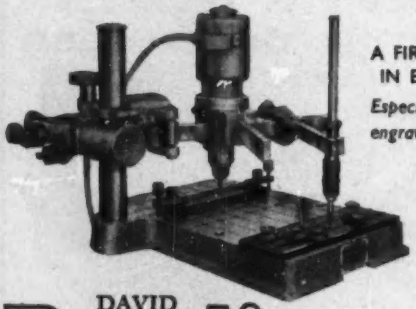


Alston CAPACITORS LTD., PARK ROAD, DISS, NORFOLK
Diss 2289
LONDON OFFICE: 551 HOLLOWAY ROAD, N.19
Archway 0015

Send for full details and list of interservice reference numbers to:-

A SUBSIDIARY OF Alma COMPONENTS LIMITED

The LOWEST PRICED engraving machine IN THE WORLD!



A FIRST CLASS JOB IN EVERY DETAIL
Especially suitable for engraving labels, etc.

DAVID **Dowling** model **848**

Reduction Range 2:1 to 4:1. Vertical adjustment to suit workpiece height. Coverage from 5in. × 3in. to 2½in. × 1½in.

Write for details of our complete range of engraving equipment.
DAVID DOWLING LIMITED · HAROLD WOOD · ROMFORD · ESSEX
TELEPHONE: INGREBOURNE 43904/5

EE 40 247 *for further details*

LANGLEY METAL PRODUCTS

Instrument Rack Panels P.O. Slotted Aluminium 10 S.W.G to B.S. 1470 N.S 4 ½ HD. FINISHED. ETCH. PRIMER

Manufactured by

F.T. DAVIS (KINGS LANGLEY) LIMITED

19" × 1¾" P.O. Units
3/6 per Unit Height
PRICE EX WORKS
PRIMROSE HILL
KING'S LANGLEY
Herts
Phone: KING'S LANGLEY 4171

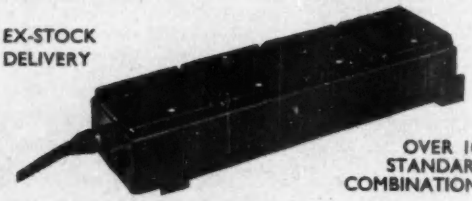
Also manufacturers of LANGLEY INSTRUMENT RACKS, CASES, ETC.

EE 40 248 *for further details*

THE LEXOR "DIS-BOARD"

For Power Extension and Expansion Everywhere

EX-STOCK DELIVERY



OVER 100 STANDARD COMBINATIONS

Full literature and Price List from:—
LEXOR ELECTRONICS LIMITED
ALLESLEY OLD ROAD
COVENTRY

EE 40 249 *for further details*

EE 40 250 for further details

The DYNATRON

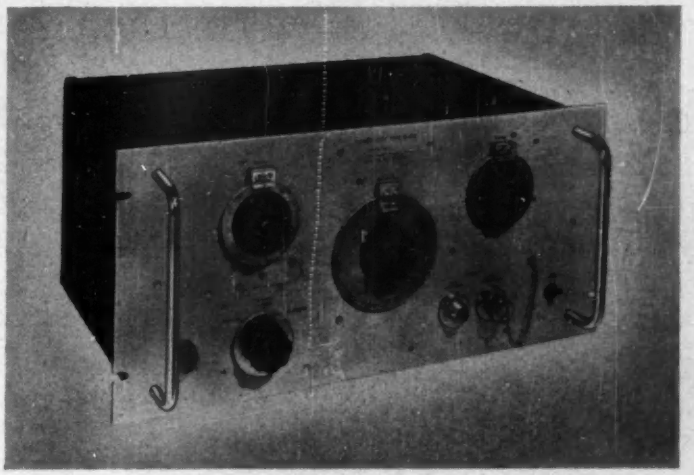
Power Unit Type N103

This power unit supplies the necessary high voltage for most types of counters used in nuclear physics — especially Scintillation counters and other proportional counters requiring extreme stability.

It is of the H.F. oscillator type with a specially designed feedback amplifier for stabilisation. Very careful design reduces ripple and spurious pulses to such a level that external filters are not normally required.

There are two outputs: High-impedance, for use when the absence of pulses and ripple is of paramount importance; and low impedance, for use when a greater current is required.

Power Unit Type N103 is normally supplied for rack mounting but is also available in a metal case.



For a full technical specification on this unit, please write to:

DYNATRON ELECTRONICS

DYNATRON RADIO LTD., MAIDENHEAD, BERKS. TELEPHONE: 5150 (10 lines)

SCALERS · PULSE ANALYSERS · POWER UNITS · TIMING UNITS · PULSE AMPLIFIERS · INSTRUMENT RACKS

Publications Bottleneck?

If this is your unhappy position, may we advise you of the service we are giving to industry throughout this country. We are an organisation of technical authors and illustrators who undertake the preparation and production of all forms of technical literature.

We are also able to offer secondment of technical authors and illustrators to work on your premises. First class service at a competitive price are at your disposal.

Now that you are aware of our services, please do not hesitate to contact us.

ENGINEERING & TECHNICAL PUBLICATIONS LIMITED

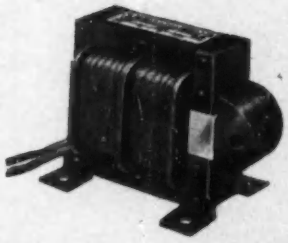
ETP

3, GREYFRIAR'S ROAD, READING, BERKSHIRE
Reading 51955 & 51611

VICTORIA BUILDINGS, 32, DEANSGATE, MANCHESTER 3
Blackfriars 3851

EE 40 251 for further details

A. C. SOLENOID TYPE SBM



Now fitted with stainless steel guides—six times the life.

Continuous 3¾ lbs. at 1"
Instantaneous to 16 lbs.

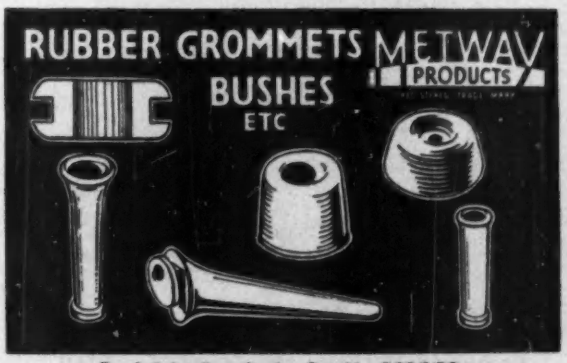
Smaller sizes available

Also- Transformers to 7kVA 3 phase

R. A. WEBBER LTD.

KNAPPS LANE, CLAY HILL, BRISTOL 5. PHONE: 65/7228/9

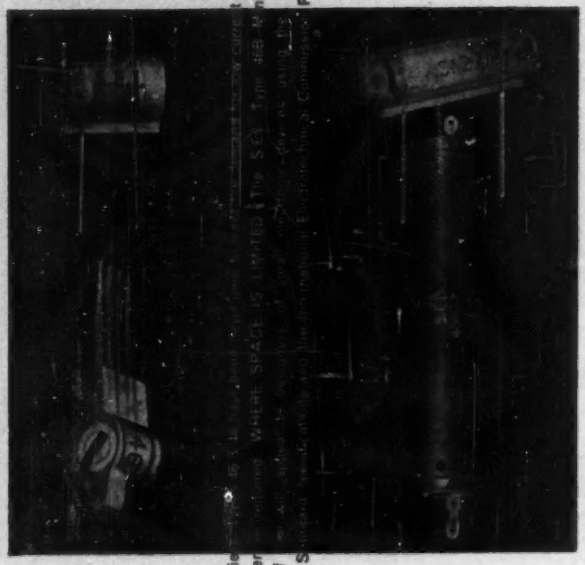
EE 40 252 for further details



For full details write for Cat. No. RGR/5/EG
METWAY, KEMP TOWN, BRIGHTON 7

EE 40 253 for further details

EE 40 254 *for further details*



The S.E.I. Tubular Selenium rectifie... electronic applications where the reliability and low cost of a metal rectifier... Miniature Selenium Bridge Rectifiers provide the solution. Their versatility of... new low voltage valves. S.E.I. rectifiers meet the requirements of British S... Publication 119. Send today for full details.

SEI
RECTIFIERS

SALFORD ELECTRICAL INSTRUMENTS LIMITED
PEEL WORKS, SILK STREET, SALFORD 3, LANCS. Tel: Blackfriars 6688 (3 lines)
London Sales Office: MAGNET HOUSE, KINGSWAY, W.C.2. Tel: Temple Bar 4069
A Subsidiary of THE GENERAL ELECTRIC COMPANY LIMITED OF ENGLAND

EE 40 255 *for further details*

SPRINGS AND PRESSINGS
for the
ELECTRONIC INDUSTRY

Manufactured in Beryllium Copper, Nickel Silver, Stainless Steel, Phosphor Bronze, Tantalum, Spring Steel etc.

We welcome your enquiries

LITCHFIELD BROTHERS LTD
BROADHOLME BELPER DERBYSHIRE

NEW COMPANY

NEW SERVICE

PROTOTYPE AND PRODUCTION units manufactured from circuit diagrams, without layout drawing office charges. items to clients drawings completed quickly, and to delivery dates.

FACILITIES include sheet metal, coilwinding, wiring shop for cable-forms, chassis and tag boards. (Valve or transistor)

LUNARTRON ELECTRONICS LTD., 42, LANGLEY ST., LUTON, BEDS

TELEPHONE: LUTON 1111

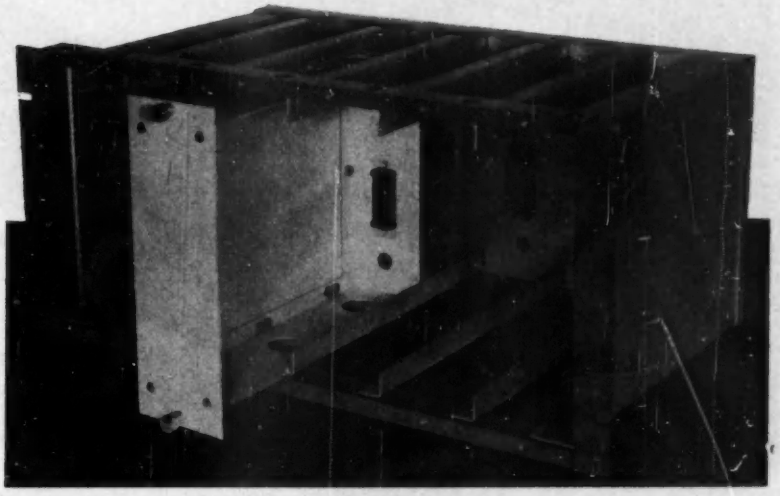
EE 40 256 *for further details*

EE 40 257 *for further details*

For circuit engineers

These standard chassis-nests and plug-in units enable circuit engineers to proceed from experimental model to saleable equipment with the minimum mechanical design and drawing office costs.

Ask for Leaflet No. 112



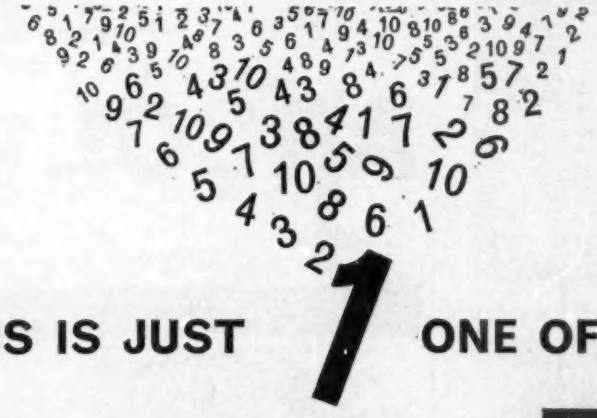
Chassis-nests measure 8¾" x 19" x 10½" (front to back)
Plug-in units measure 7¼" x 2" x 9½" (front to back)

BRUCE PEEBLES EDINBURGH

BRUCE PEEBLES & CO LIMITED

ELECTRONIC DIVISION · EAST PILTON · EDINBURGH

BRANCHES IN LONDON · MANCHESTER · CARDIFF · BIRMINGHAM · NEWCASTLE · LEEDS · GLASGOW

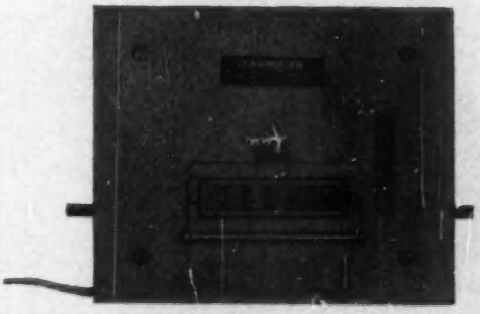


THIS IS JUST 1 ONE OF MANY MODELS

Operates as a Batch Counter, with remote resetting by push-button. Can be supplied with revolution or stroke movement.

AUTO RESETTING UNIT

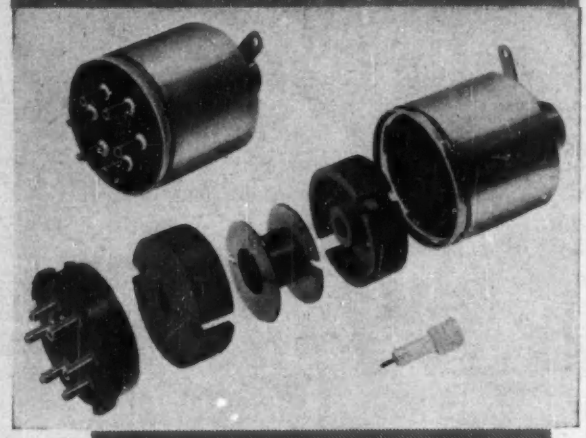
May we send fuller details?

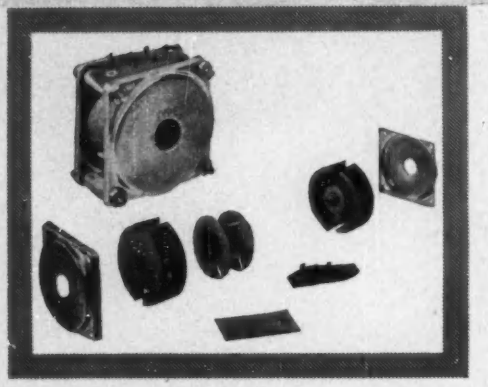


TRUMETER CO LTD MILLTOWN STREET, RADCLIFFE, MANCHESTER. TELEPHONE RADCLIFFE 2675/6
CW 8341/3

EE 40 258 *for further details*

GECOLITE
ASSEMBLIES
Adjustable Ferrite Cores

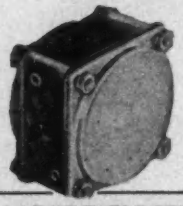




A series of adjustable ferrite core assemblies for use as high quality inductors at frequencies up to approximately 300 kc/s is readily available. Based on our range of Gecolite cores these assemblies are directly interchangeable with many non-adjustable assemblies already in use.

In many cases therefore it is possible to dispense with the slower and more tedious methods of adjustment that have to be employed.

A range of non-adjustable cores is also available.



Write for full details.

SALFORD ELECTRICAL INSTRUMENTS LTD

TIMES MILL · HEYWOOD · LANCASHIRE
Tel: HEYWOOD 6868
London Sales Office: Magnet House, Kingsway, W.C.2 *Tel:* Temple Bar 4668

A Subsidiary of THE GENERAL ELECTRIC CO. LTD. OF ENGLAND

LUMINDEX

panel mounting

LIGHT SPOT GALVANOMETERS

The World's Best for PERFORMANCE RELIABILITY APPEARANCE

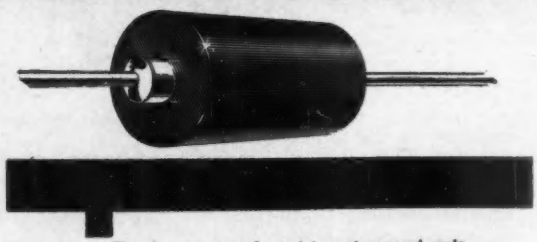
TECHNICAL DETAILS

Scale lengths: 150 or 300 mm. Sensitivity: down to $2 \times 10^{-4}\mu A$/mm. Robusts: shock, vibration, and overload proof. Linearity: better than 1%. Exceptional liquid damping using the famous SEFRAM galvano-meter elements. Multi-range models available. Also VERISPOT-bench model, STABLINDEX-field model.

Dobbie McInnes (ELECTRONICS LTD.)

55 Kelvin Avenue, Hillington, Glasgow, S.W.2. HALFWAY 3364
4 The Mount, Guildford, Surrey. Telephone: Guildford 66385.

ARCOL



The Arcol range of precision wirewound resistors, from 1/10 watt to 2 watts in size and from 0.1 ohm to 10M ohm in value with unique colour graded tolerance, is fully described in our illustrated and priced catalogue which will be sent on request.

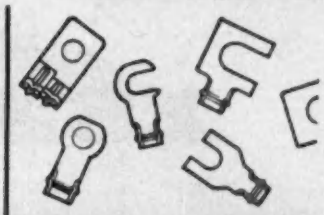
For Arcol quality and service ring NORTH 1168 or write to

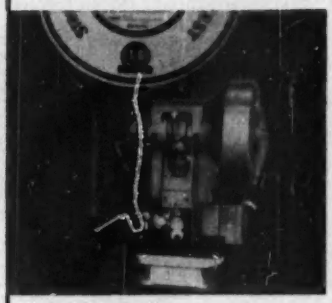
ASHBURTON RESISTANCE COMPANY LIMITED
72 Brewery Road, London N.7

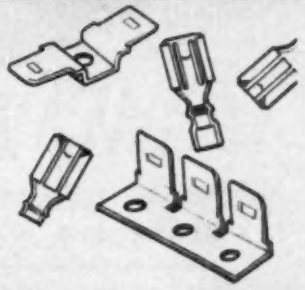
EE 40 262 *for further details*

NEW Solderless

T&B-KENT STRIP TERMINALS







For fully-automatic feed

We are now able to supply the complete range of renowned terminals by the T&B-KENT Corporation of U.S.A. Many forms are available, from the normal hooks, rings and spade to the latest varieties of "snap-on". All can be supplied in continuous lengths for automatic attachment.

T&B-KENT Strip-fed attaching machines

Very rapid, very robust — capable of over 4,000 terminal installations per hour.

T&B-KENT Male tabs

A full range covering *all* sizes of terminals—various angles, and flat—single and multi-tab. Male Tabs are supplied loose but those with wire and insulation grips are supplied in strip for automatic attaching.

Please write or phone for new catalogue which gives full details of this range.

ROSS, COURTNEY & CO. LTD

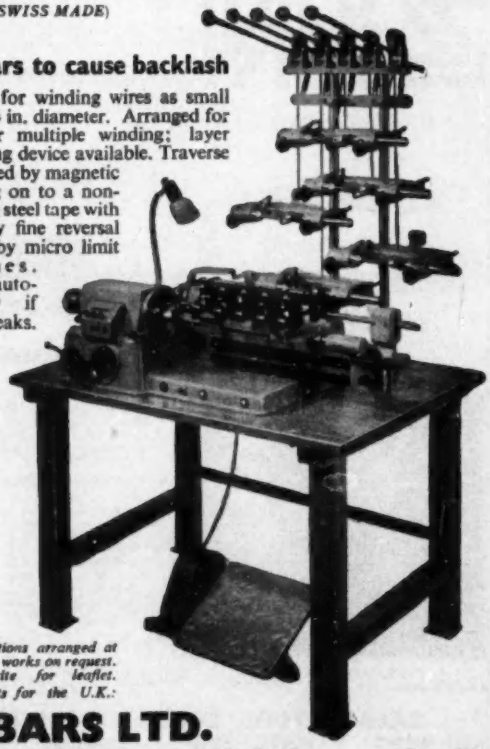
Ashbrook Road. London N19 · Tel: ARChway 1166/7/8

METEOR COIL WINDERS

(*SWISS MADE*)

No gears to cause backlash

Suitable for winding wires as small as 0.0004 in. diameter. Arranged for single or multiple winding; layer shortening device available. Traverse is obtained by magnetic clamping on to a non-reversing steel tape with extremely fine reversal settings by micro limit switches. Stops automatically if wire breaks.



Demonstrations arranged at our London works on request. Please write for leaflet. Sole Agents for the U.K.:

ACBARS LTD.

331-3 WALWORTH ROAD, LONDON, S.E.17 RODney 7822

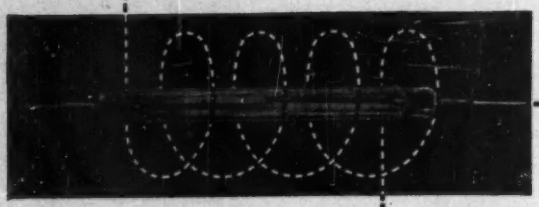
EE 40 263 *for further details*

IMPROVED
CRINKLE
SPRING WASHERS
in
BERYLLIUM COPPER
Size Range
10 B.A. to
¼" B.S.F.
Satisfactorily meets the following requirements: Corrosion Resistance, Non-Magnetic, Excellent Electrical Conductivity, High Tensile Strength up to 85 tons per sq. in., Prevents damage to surfaces to be locked together. Made to Admiralty Signal and Radar Establishment Spec. A.110000-Approved by RAE/RSP. 318 & RCL. 224.
Supplied G.C.Q., A.I.D. or A.R.B. Released.
Prices and Samples on request.
FORMERLY MARKETED BY
DAVID POWIS & SONS LTD
THOMAS HADDON & STOKES LTD · DERITEND · BIRMINGHAM 12

EE 40 264 *for further details*

XS2 Dry Reed Relay Insert

A gold-plated relay contact hermetically sealed in inert gas for absolute reliability, high speed and low contact bounce.



Maximum current	250 mA
Maximum resistive load	15 W
Maximum closed resistance	50 mΩ
Minimum open resistance	5x10¹¹Ω

Nominal operate ampere turns	120 AT
Nominal release ampere turns	60 AT
Operate time less than	2 mS
Bounce time less than	0.5 mS
Release time less than	0.5 mS

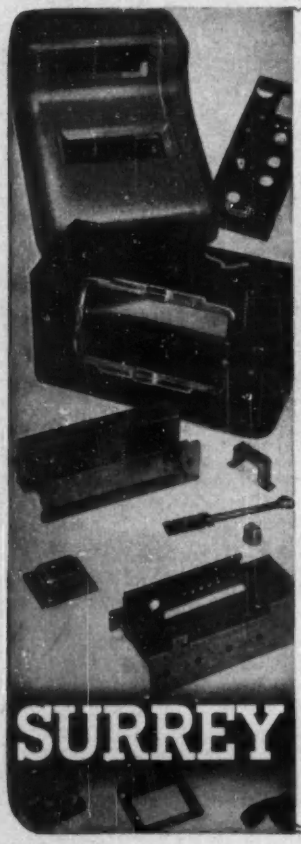
Our Technical Service Department is ready to provide further details of characteristics or application.

HIVAC LIMITED

A member of the Automatic Telephone & Electric Group

STONEFIELD WAY · SOUTH RUISLIP · MIDDX · Telephone: VIKing 1288

DRA



HAVE YOU A COMPONENT PROBLEM?

Pressed, Fabricated and Deep Drawn Components for the Electronic and Radio Industries are our business; whatever you need, Chassis, Cases, Panels, Fixing Brackets, etc., we can make them to your specification.

MANY STANDARD TOOLS IN STOCK

We produce in:-

STEEL · ALUMINIUM BRASS · PHOSPHOR BRONZE NICKEL SILVER

Self colour, plated and/or stove enamelled.

Please send us your enquiry.

SURREY STEEL COMPONENTS LTD

Trinity Road, Richmond, Surrey
Phone: Richmond 7474

EE 40 266 for further details

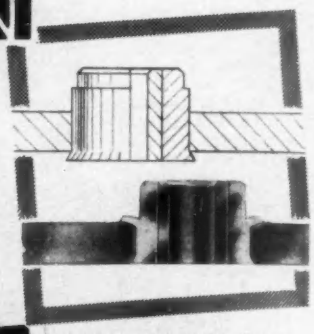
ZIN

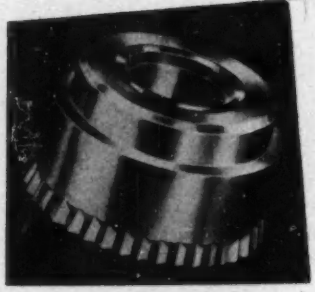
FLUSH MOUNTING

JIG BUSHES

FOR

SHEET METAL TEMPLATES





★ SAVES TIME—EASY TO FIT
Can be used on flat or curved plates. Simply punch or drill template, insert ZIN bush and secure by medium pressure FOR REALLY RIGID LOCKING.

★ COMPOSITE CONSTRUCTION
with ground tool steel insert pressed into outer body of similar material to template.

★ RANGE OF FOUR SIZES
with bores from No. 60 to ¼" dia. for templates from 20 gauge (0.0392") to 16 gauge (0.0625") and from 15 gauge (0.070") to 10 gauge (0.125").

Ask for brochure:

TALBOT TOOL COMPANY LIMITED

GRIP WORKS · ROEDALE ROAD · BRIGHTON · SUSSEX

Grams: Griptoolco, Brighton — Phone: Brighton 56833 (3 lines)

EE 40 267 for further details

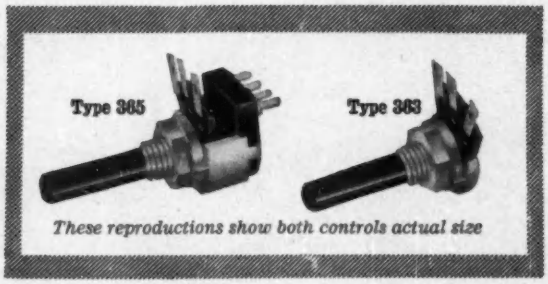
New EGEN SUB-MINIATURE CONTROLS

Types 363 and 365

Designed primarily for use in miniature transistor receivers, these new controls are of unique construction and embody many distinctive features to ensure an extremely high degree of quality and reliability.

Robustly constructed on a die-cast body only ½" diameter, each control has a tough moulded spindle ⅜" long and ⅛" maximum diameter.

Type 363 is less switch. Type 365 incorporates a double-pole single-throw switch.



These reproductions show both controls actual size

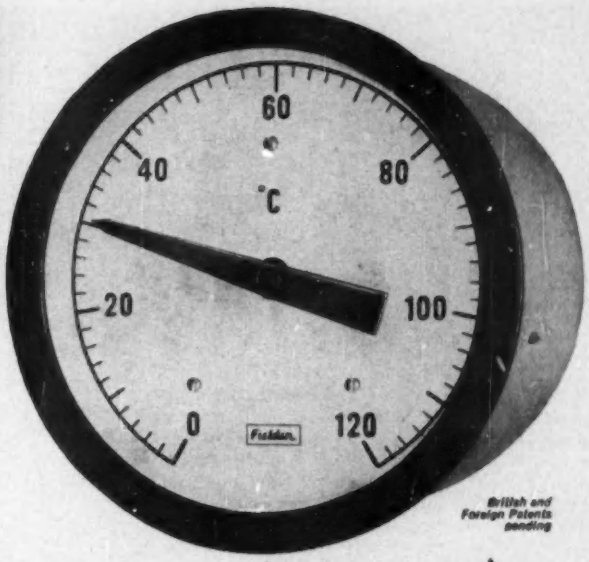
SPECIFICATION:

Resistance Range:	1000 ohms to 3 Megohms. Lower values to special order.
Resistance Law:	Log. or Linear.
Ratings: 1/10 watt.	*Switch Rating:* 50V. 150mA.

SPECIFY EGEN FOR RELIABILITY

EGEN ELECTRIC LTD
CHARFLEET INDUSTRIAL ESTATE
CANVEY ISLAND · ESSEX
'Phone: Canvey Island 691

WPS 28



British and Foreign Patents pending

NEW 'BIKINI' REGD temperature indicator

is a robust, low cost, sealed 6" diameter instrument with measuring bulb in ¼" diameter stainless steel sheath.

TRANSISTORISED, with printed circuit construction operating on 12 volt battery or mains supply.

Simple clamp mounting with robust terminals makes fitting extremely easy — no fragile capillary tubes or expensive compensating cable required — only simple wiring. Accurate rapid response.

73 temperature ranges available in °F and °C for temperatures from −200°C up to 850°C.

'BIKINI' range of instruments includes.....

TEMPERATURE CONTROLLER, with a differential of 0.5°C. Fully described on leaflet BIK. 1.

RECORDER which has a central indicating pointer. High and low electrical control or alarm facilities can be provided if required.

INDICATOR/CONTROLLER, for use with local or remote alarm or control relay.

Fielden

Write for comprehensive brochure GB/EE & price list

FIELDEN ELECTRONICS LTD · WYTHENSHAWE · MANCHESTER

Tel: Wythenshawe 3251 (4 lines) Telegrams: Humidity Manchester
ALSO AUSTRALIA, ITALY, CANADA AND U.S.A.
Branch Offices: London, Walsall, Stockton-on-Tees, Edinburgh (A. R. Bolton & Co. Ltd.) & Dublin. *Agents throughout the world.*

Indicating Recording Control

EE 40 270 *for further details*

It's a fine thing!

In fact the finer the tolerance, the greater your confidence in the precise, accurate measurement of your Shardlow Micrometer. Constant attention to engineers' problems the world over, has brought about refinements making the Shardlow Micrometer even more accurate and easy to read. This is featured in the Oblique Line Sleeve, which eliminates line reading errors of .025" (.5mm), and can be specified, at no extra cost, when ordering an Internal or an External Micrometer, but be sure it's a Shardlow—

—a very fine thing indeed!

SHARDLOW MICROMETERS LIMITED

PETRE STREET - SHEFFIELD 4

Phone: 386951/2 Grams: MICROMETERS SHEFFIELD

Valradio

TRANSISTORISED DC CONVERTERS

HIGH EFFICIENCY—over 80%.
Up to 400 watts—800 watts intermittent.
MANUALLY CONTROLLED FREQUENCY 50 c/s-60 c/s-400 c/s.
REED TYPE 50 c/s FREQUENCY METER fitted to some models.
MARINE-AIRCRAFT-MOBILE use.
POLARITY REVERSAL PROTECTION.
PROVISION FOR REMOTE CONTROL.
SQUARE WAVE AND SINUSOIDAL.
Standard range available ex-stock for T.V., Fluorescent lighting, OSCILLOSCOPES, etc.
FROM 12V, 24V, 32V, 50V.

Valradio

D.C. CONVERSION SPECIALISTS

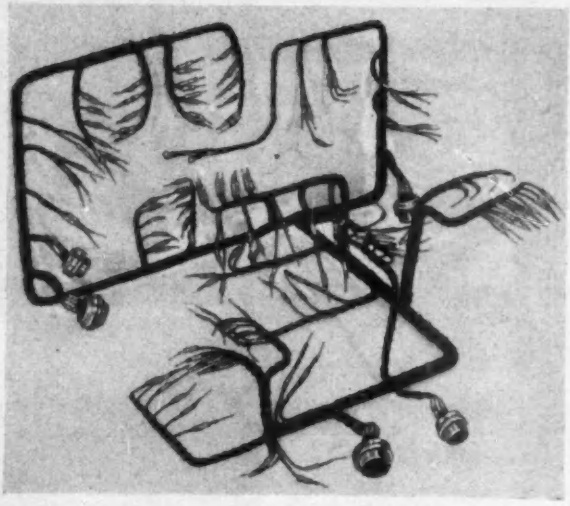
VALRADIO LIMITED

DEPT. E.E. BROWELLS LANE, FELTHAM, MIDDLESEX

Telephone: Feltham 4242.

Valradio and Stereosonoscope are the registered trade marks of Valradio Ltd.

EE 40 271 *for further details*



WE SPECIALISE

ANCA

180 ST. JOHN'S ROAD, LONDON, E.17

LARKSWOOD 7519

EE 40 272 *for further details*

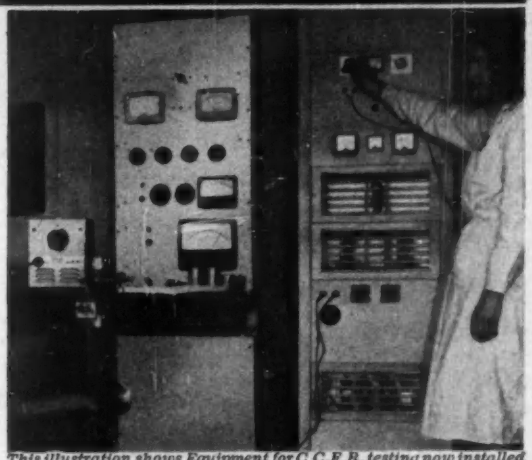
TELCON METALS LIMITED

have established the ***"constant current flux reset"*** *testing procedure*

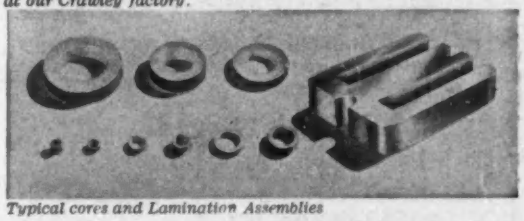
for matching cores and stacks of laminations to close limits of magnetic performance for use in transductors and saturated reactors.

This is of particular interest to designers of precision control equipment, such as AUTO-PILOTS, STABILISERS AND FUEL CONTROL UNITS for *AIRCRAFT*, INTERPOLATOR and ANALOGUE POSITION MEASURING UNITS for *MACHINE TOOL CONTROL* and similar applications.

Information on the standard range of cores and laminations in high permeability and rectangular hysteresis loop alloys (tested to this procedure) is available on request.



This illustration shows Equipment for C.C.F.R. testing now installed at our Crawley factory.



Typical cores and Lamination Assemblies

TELCON METALS LIMITED

MANOR ROYAL · CRAWLEY · SUSSEX

Telephone: Crawley 28800 · *Telex* 8748 · *Telegrams:* Telcon Crawley, Telex

Member of the BICC *Group of Companies*

High precision resistance wire

VACROM
NICKEL-CHROME

These 'Vacrom' and 'Eureka' high precision fine and superfine wires are provided to meet the most accurate demands of the electrical industry. They can be supplied fully annealed in either a bright or oxidised finish in accordance with B.S. or to meet the customer's own specifications.

EUREKA
CUPRO-NICKEL

* *Supplied bare or with standard coverings of cotton, silk, rayon, enamel and glass.*

THE LONDON ELECTRIC WIRE CO. & SMITHS LIMITED LEYTON · LONDON E.10

VACTITE WIRE COMPANY LIMITED · LINACRE LANE, BOOTLE 20 · LANCS.

L·E·W VACTITE

L.V.8

EE 40 274 for further details

direct-current

TACHOMETER GENERATOR

permanent-magnet

APPLICATIONS

- **SERVOS** The highly linear output and wide speed range are ideal for velocity or integrating servos. Low driving torque permits its use as a damping or rate signal in all types of servos.
- **INDICATING TACHOMETER** Matching indicating meters available from stock in various speed ranges.
- **SPEED TRANSDUCER** Ideal for use as a speed transducer in connection with fast-response direct-writing oscillographs.

FEATURES

- **SIZE** Miniature. Approx. Dia. 1⅛".
- **OUTPUT** Various models with outputs as high as 45 volts/1000 rpm.
- **LINEARITY** Linearity from 0 to 12,000 rpm is better than 1/10 of 1% of voltage output at 3600 rpm.
- **BRUSH LIFE** Better than 100,000 hours (10 years) of continuous operation at 3600 rpm.
- **BIDIRECTIONAL OPERATION** Output in either direction is held to a ¼ of 1% tolerance.
- **RIPPLE** The rms value will not exceed 3% of the d-c value at any speed in excess of 100 rpm.
- **CONSTRUCTION** Aluminum housings with protective treatment; stainless steel shafts; fully shielded ball bearings; Mylar insulation.

SEND FOR COMPLETE DATA

TYPICAL PRICE
Model No. SA-740A-2
(7 volts/1000 rpm) **£11.**

SINGLE UNIT - POSTPAID U. K.

Quantity Discounts

•

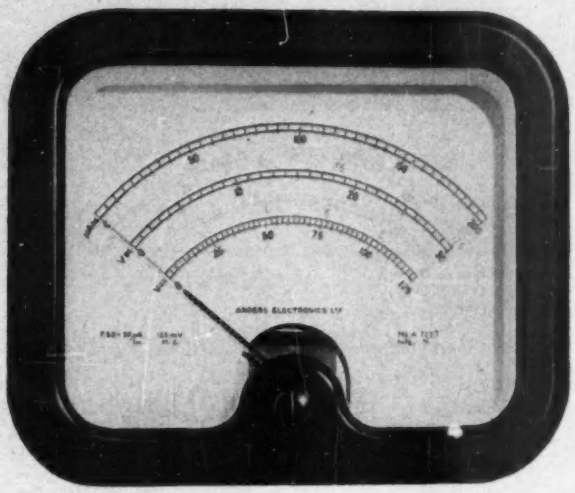
Servo-Tek

PRODUCTS CO.

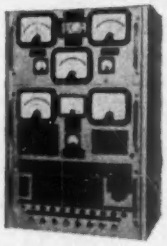
Main Office: 1086 Goffle Road,
Hawthorne, N. J., U. S. A.

CABLE ADDRESS: SERVOTEK HAWTHORNE, N. J., U. S. A.

meters made to measure



This seven-range meter, using Ernest Turner Model 605 was calibrated with special ranges by Anders at short notice for Elliott Brothers Ltd. for the special-purpose test gear shown right. All the meters in this complex installation were supplied by Anders, who have the pleasure of carrying out similar work for a number of famous manufacturers. Anders are indebted to Elliott Brothers for kind permission to illustrate this equipment.



seven-range meter, including V, mV, μA, made for Elliott's at short notice

The Anders Instrument Centre commands the largest stocks of meters in the country, unique calibrating facilities, and detailed knowledge of metering problems. Most standard meters are supplied immediately. Non-standard meters of all kinds, shapes and sizes, for special voltage and current ranges, are accurately calibrated, tested and normally ready within 10-14 days. Makes include Avo, Crompton Parkinson, EAC, Elliott, Pullin, Taylor, Turner, Weir, Weston, White. Types include moving coil, moving iron, thermocouples, electrostatic, dynamometers, from 1½" to large switchboard instruments, and complete range of accessories. Please write or 'phone for details of the Anders meter service.

ANDERS

ELECTRONICS LIMITED

103 Hampstead Road, London NW1. Tel: EUSton 1639

Contractors to GPO and Government Departments.
Ministry of Aviation approved.

METERS, ELECTRONIC AND TEST EQUIPMENT TO INDIVIDUAL SPECIFICATIONS

EE 40 277 *for further details*

DZUS

the most efficient

FASTENING

for the Engineering Industry

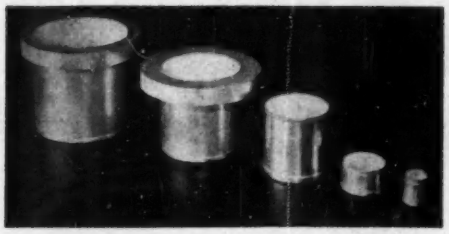
- DZUS lock or unlock instantly in a simple quarter-turn
- DZUS are vibration-proof
- DZUS are simple, sure and secure
- DZUS are ideal for hinged or removable parts needing frequent attention and inspection

DZUS Fasteners offer the most effective, most efficient, and *quickest* form of fastening for scores of vital uses in the Electronic field.

Write for full details of applications in your industry to:
DZUS FASTENER EUROPE LTD · FARNHAM FACTORY ESTATE · GUILDFORD ROAD · FARNHAM · SURREY

NaI (Tl), CsI (Tl) and LiI (Eu) SCINTILLATION CRYSTALS

STANDARD MOUNTED CRYSTALS



★ **WIDE RANGE OF CRYSTALS**
High quality NaI (Tl), CsI(Tl) and LiI(Eu) crystals available in a wide range of sizes and types of mount. Linear dimensions of crystals range from 0.003" to 12".

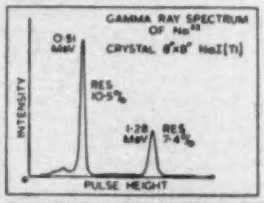
★ **EXCELLENT NaI(Tl) RESOLUTION OF GAMMA RAYS**
7.0 to 9.0% resolution on Cs^{137} gamma ray photopeak for crystals up to 3" × 3" and larger crystals average 8 to 10%.

★ **SPECIAL MOUNTINGS**
Special crystals available include well and flow types X-Ray mounts.

★ **THIN CsI(Tl) CRYSTALS FOR HEAVY PARTICLES**
Four per cent resolution on Po alpha particles obtainable.

★ **LiI(Eu) NEUTRON DETECTOR**
Mounts for slow and fast neutron detection. Resolution of 14 MeV neutrons averages 6%.

CRYSTAL PHOTOMULTIPLIER ASSEMBLIES



★ **IMPROVED RESOLUTION WITH NEW HIGH QUALITY ASSEMBLIES**
A completely new range of scintillation crystal head units combining high quality NaI(Tl), CsI(Tl) and LiI(Eu) scintillation crystals with specially selected high resolution photomultipliers.

★ **SPECIAL LOW BACKGROUND ASSEMBLIES**
Special assemblies with quartz, stainless steel, and copper components for very low level detection are available.

★ **PREAMPLIFIER-DYNODE CHAIN UNITS**
A compact cathode follower preamplifier unit including a dynode resistor chain is available for fitting in all assemblies.

Send for:
Bulletin No. 25 (Standard Mounted Crystals)
Bulletin No. 23 (Crystal-Photomultiplier Assemblies)

Send for new CATALOGUE & PRICE SCHEDULE giving full range of Scintillation Phosphors, Liquids and Crystals, and Precision Nucleonic Instruments.

Nuclear Enterprises (G.B.) Ltd.

BANKHEAD MEDWAY, EDINBURGH 11, SCOTLAND.
Tel.: CRAiglockhart 5262.

Associate Company: Nuclear Enterprises Ltd., 550 Berry St., Winnipeg 21, Canada.

7774

EE 40 278 *for further details*

EE 40 279 *for further details*

LINVAR LIMITED
FRONT PANELS
10 SWG ALUMINIUM NS4 HH

Either Natural Finish with Plastic Coating or Painted to Customer's Colour

	Depth	Type No.	Natural with plastic coating			Painted		
			£	s.	d.	£	s.	d.
19" WIDE	1¾"	LAII/1		4	2		6	1
	3½"	LAII/2		7	1		11	1
	5¼"	LAII/3		9	9		14	8
	7"	LAII/4		12	2		19	1
	8¾"	LAII/5		14	8	1	4	4
	10½"	LAII/6		17	0	1	7	0
	12¼"	LAII/7		18	4	1	10	4
	14"	LAII/8	1	1	11	1	13	11
22⅛" WIDE	1¾"	LAII/1/22		4	8		8	0
	3½"	LAII/2/22		7	9		12	5
	5¼"	LAII/3/22		11	1		16	10
	7"	LAII/4/22		13	10	1	1	8
	8¾"	LAII/5/22		16	10	1	6	2
	10½"	LAII/6/22	1	0	8	1	10	6
	12¼"	LAII/7/22	1	1	7	1	13	1
	14"	LAII/8/22	1	5	2	1	18	6

OTHER SIZES ALSO AVAILABLE

Panels are supplied with or without handle fixing holes. See our standard range of Racks, Cabinets, Cases, Trolleys, Chassis Work, etc.

LINVAR LTD.
SPECIALISE IN PROJECTS

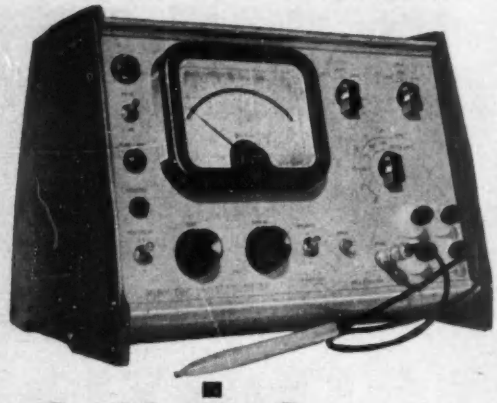
IN CONJUNCTION WITH OUR SHEET METAL MANUFACTURING FACILITIES WE OFFER DESIGN, LAYOUT AND PROTOTYPE WIRING

PLEASE ASK US TO VISIT YOU

LINVAR LTD.
BALFOUR ROAD, WEYBRIDGE, SURREY

Tel.: WEYBRIDGE 6962 & 6361

EE 40 280 *for further details*



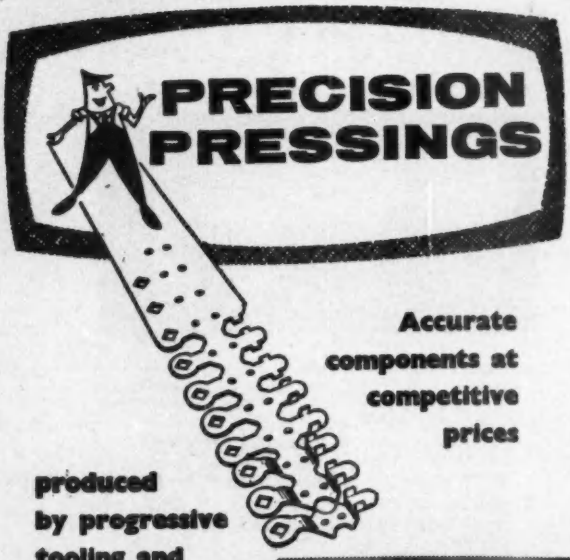
e.r.i.c

is not just another valve voltmeter: it has several unique features. As a voltmeter, with ranges of 0.5 to 2,000 volts full scale, the input impedance is so high that capacitive attenuators are used for the higher voltages, and a 'memory' retains voltage readings, if required, for several hours. On current ranges, from 0.5 to 2,000 micro-amperes full scale, the terminal voltage is only 5 milli-volts. The instrument also has six resistance ranges with 1,000 ohms to 100 megohms at centre scale. To relieve the tedium of routine work, a pen recorder can be connected to the instrument for continuous monitoring.

SOUTHERN

SOUTHERN INSTRUMENTS LTD
FRIMLEY ROAD · CAMBERLEY · SURREY

TELEPHONE CAMBERLEY 3401



Accurate components at competitive prices

produced by progressive tooling and multiform methods.

JOHN SMITH LTD.
209 SPON LANE WEST BROMWICH STAFFS.

TELEPHONE WES 2516

"MITRE MILLS" RICHARD STREET BIRMINGHAM 7

TELEPHONE ASTon Cross 2216 (4 lines)

EE 40 281 *for further details*

EE 40 282 *for further details*

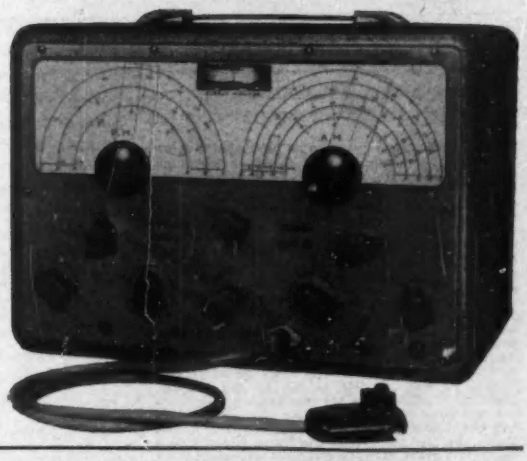
5 INSTRUMENTS in 1

AM/FM Signal Generator

WITH SWEEP & CRYSTAL CALIBRATOR

The Model 61A is designed for servicing A.M. and F.M. Receivers and provides in conjunction with an oscilloscope complete facilities for sweep alignment of R.F., I.F., and discriminator or ratio detectors of A.M. and F.M. receivers. The A.M. generator is used as a marker during sweep alignment. Fully descriptive leaflet available on request.

model 61A



SPECIFICATION

1. A.M. GENERATOR
4 Mc/s to 120 Mc/s in five bands. 120 Mc/s to 240 Mc/s (on second harmonic).

2. F.M. GENERATOR
4-7 Mc/s, 7-12 Mc/s, 70-120 Mc/s, 140 Mc/s to 240 Mc/s (on second harmonic).

3. SWEEP GENERATOR
4-7 Mc/s, 7-12 Mc/s, 70-120 Mc/s, 140 Mc/s to 240 Mc/s (on second harmonic).

4. CRYSTAL CALIBRATOR
A crystal calibrator is incorporated.

5. AUDIO Approx. 1 volt R.M.S. at 400 c/s.

TRADE PRICE: **£46.15.0**

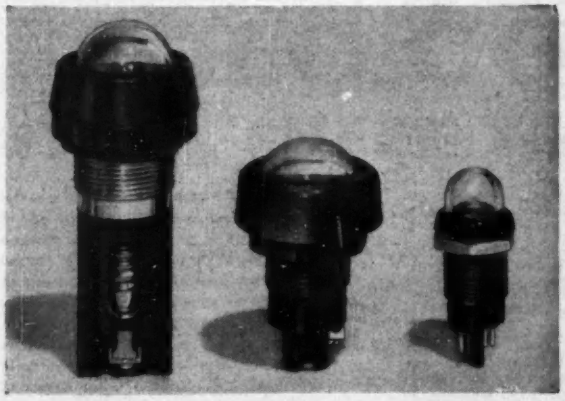
Please write for fully illustrated catalogue to:

Taylor

TAYLOR ELECTRICAL INSTRUMENTS LIMITED
Montrose Avenue, Slough, Bucks
Tel.: Slough 21381
Cables: Taylins, Slough

M

A wide range of LAMPHOLDERS for use in circuits up to 380v using NEON and FLUORESCENT neon lamps or low voltage filament lamps are available.



★ *Full details and catalogues from:*

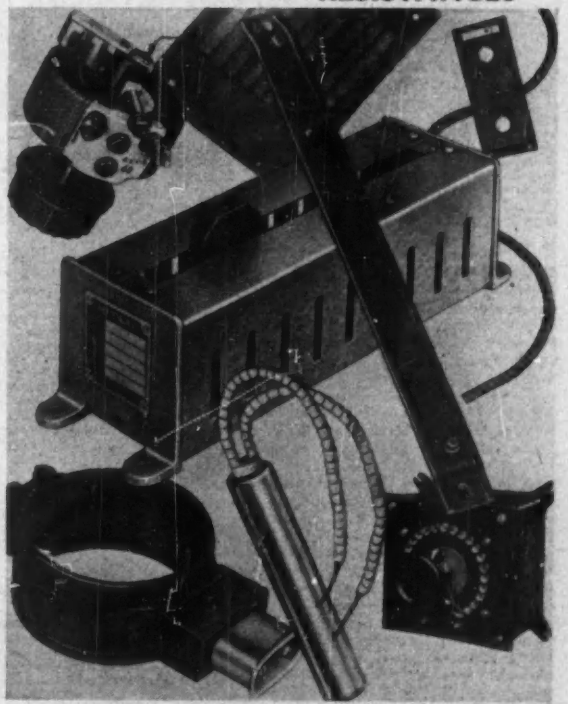
NEOFLEX LTD.

123a NEASDEN LANE, LONDON, N.W.10

Tel.: DOLLIS HILL 7671 & 7881

EE 40 283 *for further details*

METWAY HEATERS and RESISTANCES



● FOR DETAILS WRITE FOR CAT. No. JYL/30/EG
We should be pleased to receive your enquiries for specials
METWAY • KEMP TOWN • BRIGHTON 7

EE 40 284 *for further details*

CLASSIFIED ADVERTISEMENTS

Run-on Classified—The charge for these advertisements is 7d. per word. Minimum charge, 14s. Box number, 2s. extra, except in the case of advertisements for "Situations Wanted", when it is free.

Specially Spaced Classified—50s. 0d. per single column inch.

Copy, with remittance, for the above advertisements, must be received before the 14th of the month for insertion in the following issue.

Display Classified—Full Page, £75 (based on specially spaced classified rates). Half Pages, Quarter Pages and Eighth Pages *pro rata*. Copy dates: With proofs, 5th of preceding month. Without proofs, 10th of preceding month.

Blocks must be mounted.

Advertisements for publication should be addressed to:

Classified Advertisement Dept., "Electronic Engineering", 28, Essex Street, Strand, London, W.C.2.

OFFICIAL APPOINTMENTS

BRADFORD INSTITUTE OF TECHNOLOGY Department of Electrical Engineering. Applications are invited for the posts of Senior Lecturer and Lecturers in Electrical Engineering. These vacancies are created by the rapid expansion of the Department, which is mainly concerned with Diploma in Technology courses, and the posts offer exceptional opportunities for teaching, consulting and research work. Candidates should be suitably qualified to teach to final Diploma in Technology standard in electrical power or machines or electronics or telecommunications. Industrial and research experience will be a recommendation. The successful candidate will be encouraged to develop industrial contacts and undertake research for which adequate facilities are available. Salary scales (which are subject to revision at an early date) are as follows: Senior Lecturer £1,550 to £1,750 per annum; Lecturer £1,370 to £1,550 per annum. Previous industrial and research experience at a suitable level will be taken into account in fixing the commencing salary. Further particulars and forms of application may be obtained from the Registrar (Department L), Bradford Institute of Technology, Bradford 7. Henry Patten, Clerk to the Governors. W 5391

ELECTRONICISTS required by Ministry of Aviation at National Gas Turbine Establishment, Pyestock, Farnborough, Hants, to assist in the design and development of unique electronic and electrical apparatus for instrumentation associated with gas turbines and allied research. Appts. in grade of (a) Experimental Officer (min. age 27) or (b) Assistant Experimental Officer. Quals. G.C.E. 'A' Level, pass degree, H.N.C. (Elec. Eng. or Physics) or equiv. qual. Experience of modern electronic apparatus and instrumentation techniques desirable. Salary: (a) £1,087-£1,336, (b) £458 (age 18)-£801 (age 26)-£983. Opportunities (normally for candidates under 31) to compete for established (non-contributory pensionable) posts. Forms from Ministry of Labour, Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting D 546/1A. W 5393

ENGINEERS FOR Research and Development in Government Service. Following are examples of vacancies at Scientific Officer (£738-£1,222) or Senior Scientific Officer (£1,342-£1,654) level now available: Post Office Research Station, Dollis Hill, London—Long Distance Radio Communication using Satellites, involving work on Masers, parametric amplifiers, large steerable antennae, etc. (Scientific Officer or Senior Scientific Officer). Hydraulics Research Station, Wallingford, Berks—Civil or Mechanical Engineer or Physicist with knowledge of mechanics of fluids to be engaged in Studies of Hydraulic Problems in the field of civil engineering, including scale model investigation and basic research. (Scientific Officer). Royal Aircraft Establishment, Farnborough, Hants—Civil Engineer for Structures Department. Work includes Research into the Loading on Aircraft and Missile Structures, to determine their structural efficiency, and the development of suitable test equipment and techniques. (Scientific Officer or Senior Scientific Officer). There are many other vacancies for Research and Development Engineers and most scientific disciplines. All posts carry a pension. Good promotion prospects. Enquiries to Civil Service Commission (Scientific Branch), 17 North Audley Street, London, W.1, stating age, qualifications, etc. W 5408

EXECUTIVE ENGINEERS: Post Office. Pensionable posts in London and Provinces for Mechanical, Electrical and Electronic Engineers (male) at least 21 and normally under 35 on 1st September of the year in which they apply to develop and design communications systems and postal services. Qualifications: Normally degree, or Dip.Tech., in engineering or physics, or, exceptionally, evidence of very high professional attainment may be accepted in lieu. Starting salary (Inner London) £762-£1,318, according to age. Scale maximum £1,573. Promotion prospects. Write Civil Service Commission, 17 North Audley Street, London, W.1, for application form, quoting S/322. W 5410

L.C.C. SOUTH EAST LONDON TECHNICAL COLLEGE, Lewisham Way, London, S.E.4. Department of Electrical Engineering and Applied Physics. Senior Lecturer required in Electrical Engineering. Candidates should be well qualified and have had good industrial experience. Successful candidate required to teach up to I.E.E. Part III in one or more of the special subjects. Approved research encouraged. Salary (subject to ratification) £1,845-£2,060. Forms from Secretary, quoting (FE.3a/E/2977/12), returnable within two weeks. W 5416

PATENT EXAMINERS AND PATENT OFFICERS. Pensionable posts for men or women, normally under 36 on 31.12.61, for work on the examination of Patent applications. Qualifications: normally a degree, or Dip. Tech., with 1st or 2nd class honours in physics, chemistry, engineering, or mathematics, or equivalent attainment, or professional qualifications, e.g. A.M.I.C.E., A.M.I.Mech.E., A.M.I.E.E., A.M.Inst.Chem.Eng., A.R.I.C., A.Inst.P. Inner London salary £793-£1,719; starting salary may be above minimum. Promotion prospects. Write Civil Service Commission, 17, North Audley Street, London, W.1, for application form, quoting S/128. W 5397

ST. BARTHOLOMEW'S HOSPITAL, London, E.C.1. Electronic Technicians reqd. for Physics Department. Salary and conditions according to Whitley Council. Apply Clerk to the Governors. W 5412

SURREY EDUCATION COMMITTEE. Carshalton Technical Institute, Nightingale Road, Carshalton. Required as soon as possible, a Librarian. Opportunities for person interested in developing small library and promoting the habit of reading and reference among young people. Applicants must have passed Registration Examination of the Library Association. Salary scale, A.P.T.I., £645-£815, plus London Allowance. Applications, in writing, to Principal, giving details of age, education, qualifications and experience and names of two referees. W 5401

THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY, Sackville Street, Manchester, 1. A Senior Technician is required to work with a research team engaged on important chemical research, and specifically to devise, develop and operate electronic equipment playing a vital part in these researches. A recognised qualification in electronics would be desirable, but not essential. Applicants should have a good theoretical knowledge with either industrial experience or H.M. Forces training. Salary within the scale £740-£815 per annum. Additional to the above rates, £30-£50 per annum is payable for approved qualifications. The above post is for a 5 day, 40 hour week. Local Authority Superannuation Scheme. Applications giving full details should be sent to the Bursar at the above address quoting Ref. No. C.17, not later than one week after the appearance of this advertisement. W 5419

THE NATIONAL PHYSICAL LABORATORY (D.S.I.R.), Teddington, Middx., requires an Electronic Engineer as an Assistant Experimental Officer or Experimental Officer to develop and use electronic equipment for work in infra-red spectroscopy and in ultra high pressure field. Should have initiative and several years good experience of such development work. Quals.: H.N.C. or equiv. in appropriate subject. At least age 26 for E.O. Salary ranges: E.O. £1,132-£1,386, A.E.O. £680 (age 22)-£1,023. Application forms from Director, above address, quoting 70B. Closing date 12th January, 1962. W 5414

UNIVERSITY COLLEGE OF NORTH WALES, Bangor. There is a vacancy for a Technician or Senior Technician in the Department of Electronic Engineering. Applicants should be trained in electronics or as mechanics or toolmakers. Salary for a Technician will be £490 × £20 to £550, Efficiency Bar, £600 × £25 to £675 and for a Senior Technician £690 × £25 to £815. Applications, giving full particulars of experience, should be sent within 10 days of the appearance of this advertisement, to the Registrar, University College of North Wales, Bangor. W 5405

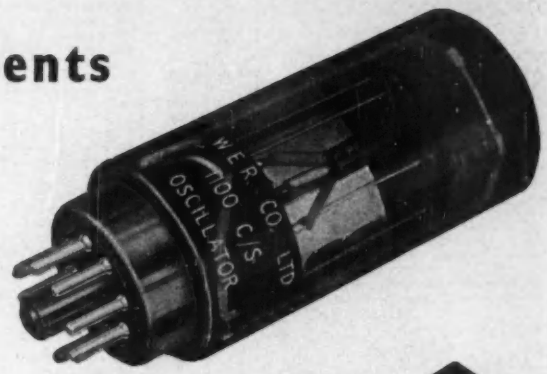
UNIVERSITY OF CAMBRIDGE, Cavendish Laboratory. Applications are invited for the post of Research Assistant on the High Voltage Electron Microscope project. Previous experience in electron microscopy is not essential but some experience in electronics and/or vacuum techniques desirable. Candidates should hold a degree or H.N.C. in Electrical Engineering or Applied Physics, or an equivalent qualification. Starting salary will be in the range £750-£1,000, according to age, experience and qualifications. Applications should be addressed to The Secretary, Department of Physics, Cavendish Laboratory, Free School Lane, Cambridge. W 5406

CLASSIFIED ADVERTISEMENTS
continued on page 224

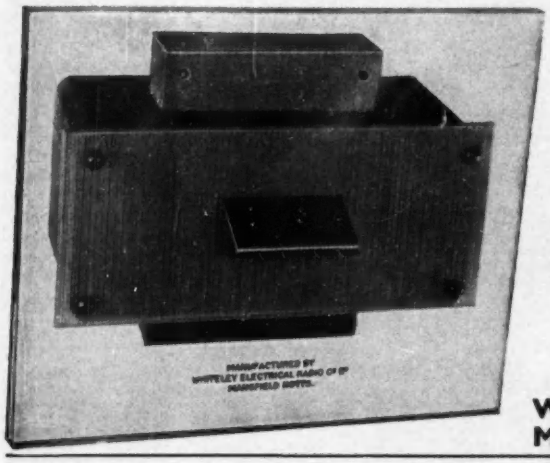
EE 40 285 *for further details*

WB electrical components

Our long experience in the design and manufacture of electrical components enables us to offer a wide range of products designed to meet with the many requirements of the electronic industry today.



This fixed frequency oscillator is constructed on a standard octal base and encapsulated in epoxy resin. Slight tuning either side of the fundamental frequency is provided by means of an adjustable core. Output: 10 mw into a 600 ohm. load. Frequency: As required within the range 700-2,000 c.p.s. sinusoidal.



On the left is an astatic wound A.F. screened line transformer with the windings encapsulated in epoxy resin. The insulation of the 'line' winding provides isolation against voltages of 30 KV RMS.

WHITELEY ELECTRICAL RADIO CO. LTD.
Mansfield, Notts. Telephone: Mansfield 1762/5

BOLTON'S
H.C. COPPER
STRIP, SHEET, TAPE & FOIL

Plain and tinned; drawn, rolled, rolled and drawn, or rolled and sheared. Sheets up to 10 ft x 4 ft in any thickness over $\frac{1}{32}$ in thinner sizes 6 ft x 3 ft or 4 ft x 2 ft

Annealed strip for generator and transformer windings, etc., with square or rounded corners, or with rounded edges; Bolton's specialize in the production, in suitable sizes of long jointless lengths weighing up to 18 cwt. Hard-drawn and semi-hard-drawn strip in coils or in straight lengths; supplied in special tempers, to close tolerances, and on drums, when required. Foil down to 0.001 in. by 3 in. wide.

THOMAS BOLTON & SONS LTD
Head Office: Mersey Copper Works, Widnes, Lancashire.
Tel.: Widnes 2022.
London Office & Export Sales Department;
168 Regent Street, W.1.
Tel.: REGent 6427.

THOMAS BOLTON & SONS LTD

EE 40 286 *for further details*

OFFICIAL APPOINTMENTS (Cont'd.)

WHITTINGHAM HOSPITAL MANAGEMENT COMMITTEE invite applications for the post of Technician to work in Electronics. The work involves medical electronic research especially in regard to neurological treatment and particularly encephalography. A previous knowledge of this work is not essential. The appointment in the first instance is for one year only but there is the possibility of extension for a further period. The post offers excellent opportunity for a young man entering the field of electronic work, and in particular the field of medical electronics is expanding rapidly. The salary is between £740 and £830 p.a. according to ability. Applications giving full details of education and previous experience in this work, if any, to be sent to the Secretary, Whittingham Hospital, Nr. Preston, Lancs, as soon as possible. W 5389

SITUATIONS VACANT

ARE YOU INTERESTED in joining a team of Design and Development Engineers engaged in producing auto-pilots for new helicopters now under development? Louis Newmark Ltd. of Croydon are desirous of appointing Design Engineers and Assistant Engineers to these posts, senior and junior appointments are available. Please send details of qualifications and experience to Personnel Manager, Louis Newmark Ltd., Gloucester Road, Croydon. W 351

BRITISH COMPANY operating in South East Asia requires Commercial Telecommunications Engineer, preferably single and aged 28 to 32. Candidates must have sound practical knowledge VHF radio and Strowger-type telephone Government/Commercial contracts. Please forward full particulars of past experience and copies of references together with passport photograph in duplicate to Box G.539, c/o Streets, 110, Old Broad Street, E.C.2. Overseas contract terms will be fully discussed at interview in London. All applications will be acknowledged. W 5418

CENTRAL ELECTRICITY GENERATING BOARD, South Eastern Region, North Thames Division. Applications are invited for the following appointment at West Thurrock Generating Station (Grays, Essex): Assistant Maintenance Engineer (Instruments) (S.V. No. 1558). Salary, N.J.B., Class M, Grade 12, Scale 9, £1,115-£1,245 plus London Weighting £50 per annum, rising eventually to Class N, Grade 12, Scale 10, £1,190-£1,325 per annum plus London Weighting £50 per annum. Suitable candidates must have a thorough knowledge of general electronics, with an emphasis on pulse circuit technique. An understanding or experience of instrumentation and/or transistors will be an advantage. His practical training should be preferably either an apprenticeship with a major radio firm, or ex Royal Air Force Radar Mechanic. Technical qualifications would be an advantage. The post is intended for a technician whose duties will include the maintenance of a Ferranti Argus Digital Computer and its peripheral equipment. Applications, quoting Reference S.V. No. 1558, stating age, qualifications, experience and present position should be sent to the Assistant Regional Personnel Officer, Central Electricity Generating Board, South Eastern Region, North Thames Division, West Farm Place, Chalk Lane, Cockfosters, Barnet, Herts, to arrive not later than 23rd December, 1961. F. W. Skelcher, Assistant Regional Director. W 5398

COMMUNICATIONS ENGINEER. Submarine Cables Ltd. at their laboratories at Erith, Kent, have an opening for a competent man for work of unusual interest on development of submerged repeaters and associated equipment and components. Experience in electronic or communication circuitry is necessary. A graduate is desirable but H.N.C. would be considered. Salary in the range £1,000-£1,400 p.a., according to qualifications and experience. Write in confidence to Personnel Manager, Submarine Cables Ltd., Christchurch Way, Greenwich, S.E.10. W 5388

DESIGN AND DEVELOPMENT ENGINEERS required for work covering most of the Electronics Field. Applicants should have a wide knowledge of valve and transistor circuitry and have had at least five years experience of Design or Development work. Academic qualifications would be an advantage but are not essential. Apply in the first instance, giving details of experience and salary expected to: Calne Electronics Ltd., Shelburne Road, Calne, Wilts. W 5409

DRAUGHTSMEN. Vacancies existi n our expanding Electronics Division for Mechanical and Electro-Mechanical Draughtsmen. The work involves the design of Consoles, Electronic Units for Government and Commercial Projects. Preference will be given to men over the age of 25 years. Capable of working with the minimum of supervision. Familiarity with the use of Ministry Specifications and preparing Drawings to D.E.F. 33 would be an advantage. Applications giving full particulars should be sent to The Personnel Manager, Box No. W 5358 c/o Electronic Engineering.

ELECTRICAL-ELECTRONIC DEVELOPMENT ENGINEER required, having some years practical experience particularly in designing transistor circuitry. Minimum qualifications H.N.C. or equivalent. Salary up to £1,100. Will be engaged in the design of new electronic instruments and control schemes. Apply to R. G. Jones, Electroflo Meters Co., Ltd., Abbey Road, London, N.W.10. Tel.: ELGar 7641. W 5399

ELECTRONIC MACHINE TOOL CONTROL LABORATORIES. Electronic Development Engineer for original development work, and Draughtsman are required to expand the work of the Company in connection with machine tool control, transducers, servo mechanisms and metrology. The location will be either at Newport Pagnell or Woking, but the entire Group will move to Newport Pagnell in six months time. Reply, stating experience and salary required, to: Sogenique (Electronics) Limited, Forsyth Road, Sheerwater, Woking. Woking 5219. W 2065

ELECTRONIC TEST ENGINEERS AND TESTERS Light Engineering Company in the Midlands is requiring the above for its Computer Division. Applicants with a knowledge of this type of Testing, and wishing to obtain well-paid positions should apply stating qualifications and experience to The Personnel Manager, Box No. W 5359 c/o Electronic Engineering.

ELECTRONIC TESTERS. Unicam Instruments, Ltd., has an international reputation for the production of scientific instruments, including spectrophotometers, which combine techniques of optics and electronics for analysis. There are a limited number of vacancies in this steadily expanding company for technicians interested in locating faults and testing complex electronic and optical equipment. Men with some theoretical knowledge, backed by practical experience in Radio, Radar or Electronics, should apply to the Personnel Manager, Unicam Instruments Ltd., York Street, Cambridge. W 5402

ENGINEERS FOR Installation and Development required. H.N.C. or C. and G. or some years experience in installation and servicing electronic equipment would be an advantage. Salaries up to £1,100 per annum. Apply, in writing, giving full particulars of qualifications and experience to Applied Research Laboratories (G.B.) Ltd., Luton Road, Harpenden, Herts. W 2062

ENGINEER MECHANIC required at L.C.C. South East London Technical College, Lewisham Way, S.E.4, for the maintenance and manufacture of electrical and physical equipment. £13 14s. 9d. for 42 hr. week. Forms, returnable within two weeks from secretary quoting (Estab. 7/E/3044/12). W 5403

EXPERIENCED ELECTRONIC ENGINEER required to take-over Audio Development work for small firm specialising in high quality Cine-Sound equipment. Situated in West London area and adjacent to Central London Line and Bus Services. Degree or H.N.C. an advantage. Five day week, Bonus System, Salary by arrangement. Preferred age group 35-45 years. Write full details in first instance to Box W 2066, c/o Electronic Engineering.

SALES ENGINEER experienced in Panel Meters and Test Instruments. Lond n area. Good salary and conditions, Pension scheme, excellent prospects. Apply in confidence to G. P. Westcott, Taylor Electrical Instruments Limited, Montrose Avenue, Trading Estate, Sough, Bucks. W 5390

SEMI-CONDUCTOR APPLICATIONS. The steadily expanding Electronic Division of an old-established Company in S.W. London require the following additional personnel to participate in an interesting development programme concerned with small and medium power equipment embodying semi-conductor devices. Design and Development Engineers with H.N.C. degree in Electrical Engineering or Electronics and several years' design experience including semi-conductor applications. Junior Engineers with O.N.C. in Electrical Engineering and a keen desire to gain experience in this exciting new field. Excellent conditions apply and a Superannuation Scheme is in operation. Salaries are competitively good. Applications should be made, giving details of age, experience and qualifications, to The Personnel Officer, W. R. Sykes Interlocking Signal Co. Ltd., 26, Voltaire Road, Clapham, S.W.4. W 5415

SOUTHERN COMMUNICATIONS LTD. Electronic Development Engineers and Junior Development Engineers. Applications are invited from qualified engineers to work on an interesting new project in our Communications division which is concerned with the design and development of a wide range of telecommunications and allied equipment. Knowledge of tape recording and transistor techniques an advantage. Applications stating full details to: Personnel Officer, Southern Instruments Limited, Frimley Road, Camberley, Surrey. W 5395

TECHNICIAN, Nuclear Engineering Laboratory, Queen Mary College, (University of London), Mile End Road, E.1. To assist in the building and operation of equipment. The work includes precision mechanical items, electronics and vacuum systems. Experience in mechanical systems an advantage. Previous experience in nuclear field not essential. Salary according to ability on scale £490 p.a. by 20/25 to possible £675. Plus London Weighting £30 to £45 according to age, and possible qualifications supplement of £30. Five day week. Four weeks annual leave. Pension scheme. Letters only to Registrar (N.E.T.), stating age, full details past experience and present work. W 5392

SITUATIONS WANTED

ENGINEER of supervisory level, experienced project duties, technical administration and liaison and company representation overseas, seeks position involving travel abroad. Short or long tours. Australia preferred, but any locality considered. Single and fully mobile. Box No. W 2063. c/o Electronic Engineering.

SERVICE

GERALD FISHER ENGINEERING LTD., Lancs. All types of electronic and electrical assembly work undertaken to your requirements. Chassis wiring, cableforms, groupboards. Hampden Road, Shaw, Lancs. Shaw 7509. W 2049

METALWORK. All types cabinets, chassis, racks, etc., to your own specifications. Philpott's Metalworks Ltd., Chapman Street, Loughborough. W 341

EXTRA PRODUCTION FACILITIES. Skilled workers + floor space + expert supervision = extra production facilities for you. See page 204. W 355

3 PROFESSIONAL ENGINEERS with design experience of advanced Semiconductor Production Plant (Diode Seal M/c's, Crystal Growers, Vacuum Furnaces, etc.) and offering progressive Design Capacity, are available for further Projects. Box No. W 2064, c/o Electronic Engineering.

CLASSIFIED ADVERTISEMENTS
continued on page 226

THE EDISWAN 16P13 Water Cooled RF Power Valve

without a jacket!

The latest Ediswan water cooled valve has no jacket. Instead there is a spiral copper water tube attached directly to the anode. This method is much more efficient, keeps the valve cooler, and makes it cheaper to install and easier to maintain.

Tot up the extra advantages and then switch to these new valves for any application where you are at present using water jacketted valves.

1. No water jacket—simplifies installation.
2. Seals eliminated reducing leakage risk.
3. Low water requirements—1 litre/3 kW anode dissipation.
4. More compact than conventional water cooled valves of similar rating.
5. Includes the Ediswan patented over-dissipation protection device.

RATINGS:		15P12	16P13
Filament voltage (volts)	Vf	5·0	8·0
Filament current (amps)	If	32·5	26·0
Maximum anode voltage (kV)	$V_{a(max)}$	6·0	8·0
Maximum anode dissipation (kW)*	$P_{a(max)}$	0·6	3·0
Maximum operating frequency (full rating) (Mc/s)	$f_{(max)}$	1·5	1·5
Maximum RF power output (kW)	P_{out}	2·5	7·5

Write for a copy of our latest catalogue
EDISWAN INDUSTRIAL VALVES AND CATHODE RAY TUBES.

** Other valves with anode dissipations up to 6 kW will be available shortly.*

EDISWAN INDUSTRIAL VALVES & CATHODE RAY TUBES

AEI
EDISWAN

Associated Electrical Industries Limited
Radio & Electronic Components Division,
155, Charing Cross Road, London W.C.2. Telephone GERrard 9797
16/22

CAPACITY AVAILABLE

DON'T FORGET PRECISION UNITS LTD., Seacrest Works, Church Road, Parkstone (1664) Dorset, for Machine Engraved Labels in plastic and metal. Keen prices. Reliable delivery. First class productions. W 5404

OLSON ELECTRONIC LIMITED for coil winding. 282, Sussex Way, London, N.19. Archway 2342. W 2061

PATENTS

PATENT No. 714116. New or improved Contact Device for Conveying Current to Electrical Switches in Motor Vehicles. The Proprietors of Patent 714116 desire to enter into arrangements by way of licence or otherwise on reasonable terms to ensure its full development and commercial working in this country. Address enquiries to: W. P. Thompson & Co., Chartered Patent and Trade Mark Agents, 12, Church Street, Liverpool, 1. W 2060

FOR SALE

50,000 PRECISION INSTRUMENT GEARS of all types from stock. (Now including spiral bevels.) Write for fully comprehensive catalogue. The Davall Gear Company Limited, Potters Bar, Middlesex (Telephone No. Potters Bar 57141 — 10 Lines). W 357

EDUCATIONAL

CITY AND GUILDS (Electrical, etc.) on "NO PASS—NO FEE" terms. Over 95 per cent successes. For details of modern courses in all branches of Electrical Engineering. Applied Electronics, Automation, etc., send for our 148-page handbook —FREE and post free. B.I.E.T. (Dept. 337c), 29 Wright's Lane, London, W.8. W 316

THE POLYTECHNIC, 309 Regent Street, W.1. Department of Mathematics and Physics. The following courses of lectures will be given in the Spring Term 1962: Semi-Conductor Circuit Elements on Tuesdays from 7.00 to 8.30 p.m., commencing 9th Jan. 1962. Nuclear Spectroscopy on Wednesdays from 6.30 to 8.00 p.m., commencing 10th Jan. 1962. Fee for each Course: £1 1s. Further details available on application to the Director of Education. W 5394

TV. AND RADIO—A.M.Brit.I.R.E., City & Guilds, R.T.E.B. Certificate, etc., on "NO PASS—NO FEE" terms. Over 95 per cent successes. For details of Examination and Home Training Courses (including practical apparatus) in all branches of Radio, T.V. and Electronics, write for 148-page handbook—Free. B.I.E.T. (Dept. 337H), 29 Wright's Lane, London, W.8. W 187

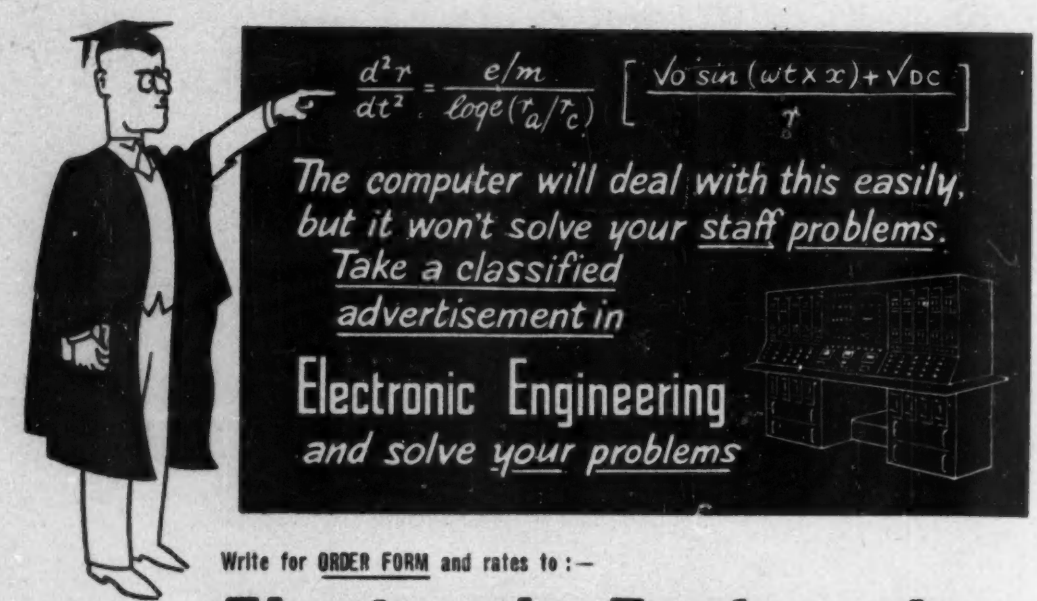
U.K.A.E.A. Harwell Reactor School. Instrumentation of Reactors Course No. 1. To be held at Durley Hall, Bournemouth from 12th-23rd February 1962. Fee £52 10s. exclusive of accommodation. This course has been designed to replace the Control and Instrumentation of Reactors Course and is intended for those who have a direct interest in the instrumentation of nuclear reactors. It is assumed that participants will have some knowledge of the basic principles of the subject. Application forms and further details for this course can be obtained from: The Manager, Reactor School, A.E.R.E. Harwell, Berkshire. W 5417

LEARN RADIO AND ELECTRONICS the New Practical Way! Very latest system of experimenting with and building radio apparatus—'as you learn'. Free Brochure from Dept. EE10, Radiostructor, Reading, Berks. W 353

THE COLLEGE OF AERONAUTICS. Two-Year Diploma Course 1962-1964. Applications are invited from suitably qualified men and women who wish to enrol for the Two-Year Diploma Course which begins in October, 1962. This post-graduate course in Aeronautical Science and Engineering is intended primarily for University Graduates in Engineering, Science or Mathematics. Technical College students and others who possess a Higher National Certificate, Diploma or equivalent qualification and attain the required entrance examination standard may also be accepted. The Curriculum includes the subjects of Aerodynamics, Aircraft Design, Electrical and Control Engineering, Materials, Production and Industrial Administration and Aircraft Propulsion in all of which subjects a major specialization may be taken. Lectures and laboratories in Mathematics and Flight are obligatory for all students. All applications will be considered by the Board of Entry which may call candidates to attend at the College for written Entrance Examination in Engineering, Physics, Mechanics and Mathematics, to be held on Monday, 2nd April, 1962. Exemption from this examination will normally only be given to candidates possessing approved university degrees in Science or Engineering, or reading for such degrees. The Board may also require attendance for personal interview at a later date. Candidates who possess Bachelors Degrees with 1st or 2nd Class Honours in Aeronautics, and also in Science or Engineering if they have adequate post-graduate experience may, at the discretion of the Board of Entry, be accepted for entry to the second year of the course and qualify for the Diploma (D.C.Ae.). Further information about the course and forms of application, which must be completed and returned not later than Saturday, 10th March, 1962, may be obtained from the Registrar, The College of Aeronautics, Cranfield, Bletchley, Bucks. W 5411

AGENCIES

AGENCIES REQUIRED in European countries to market a new and advanced Transfer Function Analyser. Wenbrook Controls, Ltd., Ravenoak Road, Cheadle Hulme, Cheshire, England. W 5400


$\frac{d^2r}{dt^2} = \frac{e/m}{\log_e(r_a/r_c)} \left[\frac{\sqrt{o} \sin(\omega t \times x) + \sqrt{DC}}{r} \right]$
The computer will deal with this easily, but it won't solve your staff problems.
Take a classified advertisement in
Electronic Engineering
and solve your problems

Write for ORDER FORM and rates to :—

Electronic Engineering

Advertisement Department 28, Essex Street, Strand, London, W.C.2. **Tel: CENtral 6565**

EE 40 289 for further details

Variac

REGD. TRADE MARK

FOR CONTROL OF

VOLTAGE

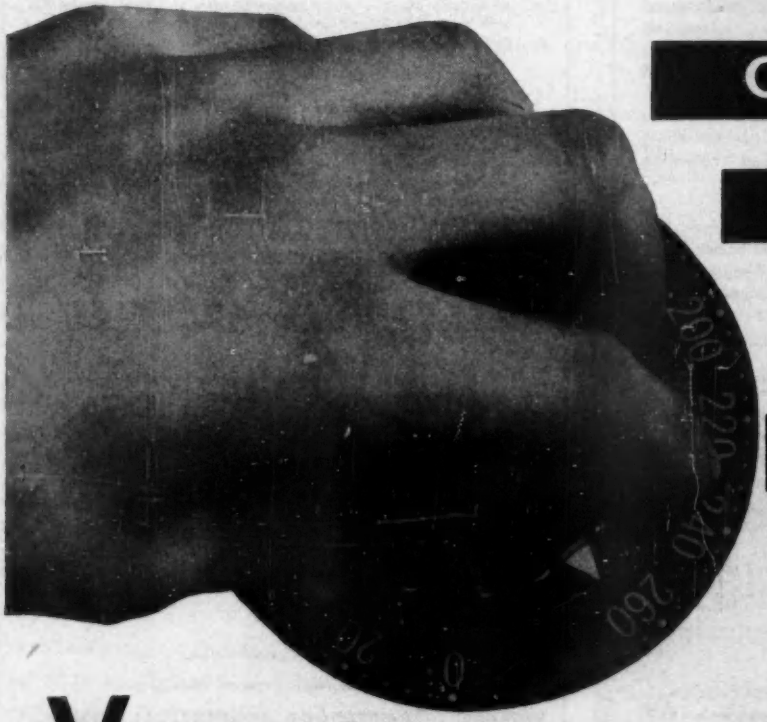
CURRENT

POWER

SPEED

HEAT

LIGHT



Variac... *THE ORIGINAL AND BEST VARIABLE TRANSFORMER*

Made in England by The Zenith Electric Co. Ltd., London, and exclusively distributed in the U.K., Eire & British Colonies by:-

Claude Lyons Ltd.

VALLEY WORKS · HODDESDON · HERTS · TEL: HODDESDON 4541-4

76 OLD HALL STREET · LIVERPOOL 3 · TEL: CENTRAL 4641-2

CL 61/1A

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

PRODUCTION GROUP

INSTRUMENT MECHANICS

Windscale and Calder Works, and Chapelcross Works require experienced men with knowledge of electronic equipment and/or industrial instrumentation for fault diagnosis, repair and calibration of a wide range of instruments used in nuclear reactors, radiation laboratories and chemical plant. This interesting work involves the maintenance of instruments using pulse techniques, wide band low noise amplifiers, pulse amplitude analysers, counting circuits, television and industrial instruments used for the measurement of pressure, temperature and flow.

Men with Services, Industrial or Commercial background of radar, radio, television, industrial or aircraft instruments are invited to write for further information. Training Courses in Specialised Techniques are provided for successful applicants having suitable instrumentation background. Married men living beyond daily travelling distance will be eligible for housing. A lodging allowance is payable whilst waiting for housing. Working conditions and promotion prospects are good.

Applications to:—

Works Labour Manager, Windscale and Calder Works, Sellafield, Seascale, Cumberland.

or

Works Labour Manager, Chapelcross Works, Annan, Dumfriesshire, Scotland.

You'll find room to expand with

'ENGLISH ELECTRIC'

VALVE COMPANY LIMITED

Technical Assistants for Electronic Equipment Maintenance

The electronic equipment required for testing specialised valves and tubes is complex and varied.

We require young men with a sound knowledge of electronic circuitry to maintain existing equipment and to assist in the design and building of new.

Men with experience of radar, U.H.F. and V.H.F. radio transmitters preferred, and academic qualifications should be H.N.C. standard.

If you would like to be considered for one of these progressive positions write to: **Group Personnel Service, English Electric House, London, W.C.2 quoting reference EE 1590G**

'ENGLISH ELECTRIC'

VICKERS-ARMSTRONGS

(ENGINEERS) LIMITED

BARROW-IN-FURNESS, LANCASHIRE

TWO OPPORTUNITIES WITH NUCLEAR SUBMARINE TEST TEAM

The Marine Propulsion Research and Development Department of Vickers-Armstrongs (Engineers) Limited invite applications for two posts on a test team concerned with prototype propulsion machinery for British nuclear submarines.

The initial phase of this work, which is expected to last for several years, is being carried out at Dounreay on the North East coast of Scotland. The successful candidates will be expected to become members of an integrated team and must have a sufficiently wide knowledge to be able to appreciate the work of their colleagues in related fields.

The vacancies are as follows:—

ELECTRONIC ENGINEER

to be responsible to the Senior Electronic Engineer, primarily for the instrumentation of the reactor, both nuclear and conventional. He will also be expected to acquire a sound knowledge of all the instrumentation of the conventional machinery as the project proceeds. Preference will be given to an engineer with some years of experience in the reactor instrumentation field.

ELECTRICAL ENGINEER

to be responsible to the Senior Power Engineer, primarily for the proving of the electrical systems in the prototype, and for the documentation of the proving tests.

Applicants should be graduates or Associate Members of the I.E.E. or Brit. I.R.E. The posts offer an ideal opportunity for the engineer who wishes to gain experience over the whole field of electrics, ranging from reactor physics to high-power generation, and there are excellent prospects for advancement.

Successful applicants would be required to join the Company's Contributory Superannuation Scheme when eligible.

Applications, which will be treated as strictly confidential, should give full details of qualifications, experience and current salary, and be addressed to:

THE MANAGER, MARINE PROPULSION,
RESEARCH AND DEVELOPMENT DEPARTMENT,
VICKERS - ARMSTRONGS (ENGINEERS) LIMITED,
BARROW-IN-FURNESS, LANCASHIRE.

FERGUSON RADIO CORPORATION LTD.

(Electronics Division)

Ambitious Young ENGINEER

offered a position in expanding Laboratory group developing industrial control equipment and transducers, using modern electromagnetic and semiconductor techniques.
Excellent scope for originality together with good prospects of promotion. Salary according to qualifications and experience. Pension fund. Sports Club.

Apply with brief details quoting Ref. No. L.5159 to:
Personnel Manager,
Great Cambridge Road, Enfield, Middx.

New Advances in Direct Conversion of Heat to Electricity

General Atomic Europe is considering expansion of its activities into new areas of modern technology, including advanced systems for the direct conversion of heat to electricity. This work would complement important programs in these fields which are now being carried on at the San Diego, California, laboratories of General Atomic Division of General Dynamics Corporation, U.S.A.

Programs at General Atomic U.S.A. include the development of compact, low-cost thermoelectric and thermionic devices for a variety of industrial and communications applications, as well as advanced systems to provide auxiliary electric power for space vehicles. Devices are being built which use solar and chemical heat sources, in addition to those using nuclear energy.

General Atomic Europe is interested in receiving inquiries from creative engineers and scientists with outstanding experience in the development of new products. Openings include several senior positions which are available to scientists and engineers having extensive backgrounds in both devices and materials.

In addition to these programs in direct conversion, other areas of activity outside the nuclear field at General Atomic include transistorized control systems, solid state dc to ac converters, high temperature semiconductors, acoustic thermometers, and new electromagnetic machines for metal-forming.

Inquiries Invited from Engineers and Scientists

Inquiries concerning positions available in these programs are invited from mechanical and electrical engineers, metallurgists, chemists, and physicists interested in such fields as: high vacuum technology, the development of insulators, semiconductor-conductor bonds, thermoelectric materials fabrication, and the production of thermoelectric converters and generators.

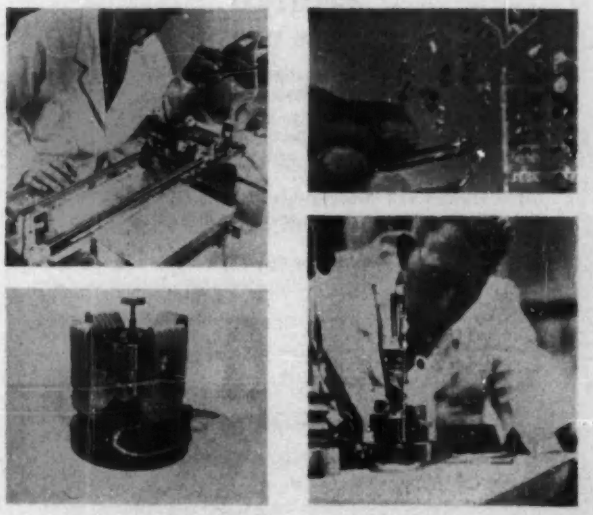
Please address inquiries to: General Atomic Europe, Weinbergstrasse 109, Zurich 6, Switzerland.

Developments at General Atomic

The following recent developments are the result of the teamwork of a large number of scientists and engineers at the Laboratory in San Diego:

- Tiny thermoelectric elements — hundreds of times smaller than other units with the same power output — made possible by the development of new high-strength, negligible resistance bonds of semiconductors to conductors.
- New-concept solar thermoelectric panels for space vehicle auxiliary power. Weighing as little as 50 pounds per kilowatt, these light-weight panel generating systems offer marked advantages over present solar cells.
- Advanced thermionic converters for electric generating stations of the future, including early experimental models which have already produced over 90 watts of power at efficiencies of 10 per cent, directly from the heat of nuclear fission.
- Compact low-cost thermoelectric generators that convert gas heat to electricity. An experimental five-watt thermoelectric generator, designed for mass production, is being built for the American Gas Association, representing the U.S. gas distributing industry.
- Thermoelectric units for refrigeration and air-conditioning.
- Development of new high temperature thermoelectric materials, including rare earth sulfides. Fabrication of high-temperature thermoelectric modules to operate at temperatures up to 1000°C.

Firms interested in obtaining information on specific applications are invited to write General Atomic Europe, Weinbergstrasse 109, Zurich 6, Switzerland.



Top left, tiny thermoelectric elements developed by General Atomic; top right, solar thermoelectric panels for auxiliary space power; bottom left, cesium cell thermionic converter; bottom right, experimental unit to convert gas heat directly into electricity.

GENERAL ATOMIC EUROPE *A Member of the General Dynamics Group*

MILAN ZURICH DUSSELDORF VIENNA

Ferranti electronics

announce vacancies in their

SEMICONDUCTOR GROUP

handling important new projects in

SOLID-STATE MICROCIRCUITRY

for

ADVANCED COMPUTERS

The Group is housed in modern laboratories at the Company's Wythenshawe branch, with easy access to pleasant residential areas of rural Cheshire. Candidates should be graduates with good previous experience in the semiconductor field with particular reference to silicon devices.

Forms of application can be obtained from **T. J. Lunt, Staff Manager, Ferranti Limited, Hollinwood, Lancs.** Please quote reference JRP/2.

IMPERIAL CHEMICAL INDUSTRIES LIMITED

PLASTICS DIVISION

has vacancies at its headquarters at Welwyn Garden City for the following appointments:

(a) **Designers** (Electrical) for power and lighting installations in industrial plant. (Experience with British Standards, Flameproof and intrinsically safe practice would be an advantage.)

(b) **Designers and Draughtsmen** (Instruments) for application of instrumentation, including automatic control of industrial plant.

(c) **Experimental Officers** for (i) work on instrument evaluation and automatic control systems (knowledge of machine tools and workshop practice would be an advantage.)

(ii) work on development of electronic equipment for use in the measurement and control field. (A knowledge of transistorized circuits and pulse techniques would be an advantage.)

Candidates should have an appropriate Higher National Certificate or Ordinary National Certificate and experience in the field offered.

Excellent conditions of service include a 37½ hour, five day week, a Pension Fund and a Profit Sharing scheme. For married men assistance is given towards removal expenses and a lodging allowance.

Apply briefly, quoting reference No. 5147, to the Personnel Officer, Imperial Chemical Industries, Plastics Division, Bessemer Road, Welwyn Garden City, Herts.

BBC

SENIOR ENGINEER

required for

DESIGNS DEPARTMENT

based in London

Responsibilities include the mechanical development of equipment used for sound and picture recording in the sound and television services and advising on mechanical problems arising in a wide range of other equipment used in a broadcasting service.

The candidate must be able to work on his own initiative with a minimum of supervision and the post offers excellent opportunities for original thought and the development of new ideas.

Experience in the design, development or construction of light mechanisms is necessary and a general knowledge of audio frequency electronics is desirable. An acquaintance with film techniques and with the equipment used for sound recording on tape would be an advantage.

Applicants (British subjects) should have a degree or an equivalent professional qualification in mechanical engineering, but a record of successful work in the development of light mechanisms would be an acceptable alternative. The salary offered will be according to qualifications and experience, in a range with a maximum of £2,225 p.a., but a higher maximum would be offered for exceptional qualifications and experience.

Please write for application form to Engineering Recruitment Officer, Broadcasting House, London, W.1., quoting ref. 61.E.240.E.E.

DO YOU WANT AN EASY LIFE?

Then PLEASE don't answer this advertisement. We can't offer Utopia, but we can offer . . . . .

- Interesting and progressive work on a variety of new projects
- Above average salaries with suitable advancement for the men who produce results
- Readily obtainable housing in a pleasant location
- Scope for initiative and a friendly atmosphere

Our present requirements are :

AN ELECTRICAL ENGINEER who has specialised in the design and development of light current devices. Applicants should possess H.N.C. or equivalent and be familiar with the design of relay circuits for alarm and control systems, solenoids, switchgear and the selection of f.h.p. motors and proprietary components. Some knowledge of servo control systems would be advantageous.

ELECTRONIC ENGINEERS experienced in pulse techniques and transistor circuit design to work on the development of new nuclear electronic equipment.

ELECTRONIC DRAUGHTSMEN suitably qualified and experienced for the design of electronic equipment on a wide variety of projects.

AN ELECTRICAL ESTIMATOR for detailed estimating and appraisal of light electrical and electronic work.

If you are interested in these openings, please write in complete confidence and without obligation to:

● *The Personnel Manager*,
Plessey Nucleonics Limited,
Weedon Road,
NORTHAMPTON

Plessey

● ●

PRODUCTS WANTED FOR MANUFACTURE/SALE IN THE U.S.A.

We are interested in first marketing products in the U. S. A. with an eventual view toward licensing to manufacture same.

Communicate with

A. Lederman, President; MSI Electronics Inc., 116-06 Myrtle Ave., Richmond Hill 18, (N.Y.C.,) NY., U.S.A.

AMPEX

manufacturers of precision magnetic recording equipment, invite applications for the post of

VIDEO ENGINEER

at their Arkwright Road, Reading, premises.
The successful applicant will be concerned with engineering and test in connection with the Ampex

VIDEOTAPE *

television recorder. He must have experience of television development or television studio operation. H.N.C. or equivalent standard qualification is desirable.

Free sickness insurance.

Contributory pension and life assurance scheme.

Please apply: **The Personnel Manager, Ampex Electronics Ltd., 72 Berkeley Avenue, Reading, Berks.** Tel.: Reading 55341.

* TM Ampex Corporation.

ELECTRONIC DEVELOPMENT ENGINEER

required for interesting work with a small team on the development of nucleonic instruments for use in industry. The development of systems using photomultipliers, ionisation chambers, etc. and associated measuring equipment is also covered.

Engineers with experience of nucleonic or industrial electronics are invited to apply, giving details of experience and qualifications, to

The Manager,
SAUNDERS-ROE & NUCLEAR ENTERPRISES LTD.
North Hyde Road, Hayes, Middx.

Ferranti *electronics*

have vacancies for

MICROWAVE ENGINEERS AND PHYSICISTS

In the following categories

(i) **DEVELOPMENT OF MICROWAVE VALVES** in the Company's Wythenshawe Laboratories. Candidates should be of graduate status and previous experience of valve development is preferable.

(ii) **DEVELOPMENT OF PARAMETRIC AMPLIFIERS.** Candidates should be of graduate status and possess experience of development work in the microwave field.

(iii) **TESTING OF MICROWAVE VALVES** in the Company's Chadderton Production Department for work associated with high power microwave klystrons. Candidates should preferably have H.N.C. (Elect) and experience of organising test schedules for industrial and Service requirements.

These appointments will, in all cases, carry salaries which are fully commensurate with candidates' qualifications and experience. The Company has a Staff Pension Scheme and a Dependents' Insurance Scheme.

Forms of application may be obtained from T. J. Lunt, Staff Manager, Ferranti Limited, Hollinwood, Lancs. Please quote reference JRP

There are opportunities for

TECHNICIANS

in the Test Department of the Research Division of

A. V. ROE & CO. LIMITED

at WOODFORD, CHESHIRE

The work includes the testing of electronic assemblies, instruments and servomechanisms and applications are invited from:

A Former members of the Armed Forces, or those nearing the end of their service, or who have been trained in Radar, Wireless or Instruments.

B Applicants with O.N.C. (Electrical) and experience of electronics.

C Applicants with the Telecommunications Certificate or equivalent.

D Applicants with no formal qualifications but with at least three years' experience of the testing of electronic components.

E Applicants with experience in the testing of hydraulic components.

Salaries are competitive and are subject to regular review. A superannuation scheme is in operation and there are excellent canteen facilities.

The Weapons Research Division is situated at an airfield in a pleasantly rural part of Cheshire with good access to shops, housing and transport.

Please write, quoting reference WRD/R.53/D and giving details of your background and field of interest, to:

The Personnel Officer,

A. V. ROE & CO. LIMITED, Greengate, Middleton, Manchester

MEMBER OF HAWKER SIDDELEY AVIATION

MINISTRY OF AVIATION

PROFESSIONAL ENGINEERING

Unique opportunities for interesting and progressive careers at establishments mainly in the South of England covering a wide field including

AERONAUTICS, AIRCRAFT, NAVIGATION, GROUND SERVICES.
GAS TURBINES, ROCKET PROPULSION, GUIDED WEAPONS.
ELECTRONICS, INSTRUMENTS, CONTROLS.
TELECOMMUNICATIONS, SIGNALS, RADAR.
ARMAMENT, EXPLOSIVES, NUCLEAR DEVELOPMENT.

Vacancies for:—

A. **TECHNICAL ASSISTANTS** (for those with apprenticeships and hons. or pass degree or Dip. Tech. or National Certificates or Diplomas for Parts I and II leading to graduate membership of Institutions of Civil Mech. or Elect. Engineers or Royal Aeronautical Society), for two years (approx.) professional training leading to Professional Engineering posts.

Salary: £707 (age 21) to £1,092 (National Scale).

B. **PROFESSIONAL ENGINEERS** (for those with qualifications as for Technical Assistance as at A. above but for Parts I, II and III, leading to corporate membership of these institutions) for posts in applied research, development and design, production, manufacture or inspection.

Salary: £936 (age 25) to £1,430 (National Scale).

ARE YOU INTERESTED?

Just send an addressed envelope for application form and further details to Ministry of Aviation, Est. 2B1.(BR), Room 517, Adelphi, John Adam Street, London, W.C.2. Mark your envelope on top left hand corner A or B as appropriate.

Ferranti

WYTHENSHAWE

Manchester

have vacancies for

ELECTRONICS ENGINEERS

to produce technical publications covering industrial process control and missile guidance and control systems. The work is varied, interesting and provides considerable scope for the exercise of creative skill.

Applications are invited from engineers possessing a degree in Physics or Electrical Engineering or H.N.C. (Electronics) or equivalent qualification gained academically or from wide practical industrial or Service experience.

Successful applicants will be offered a salary based on experience and qualifications within the range of £950 to £1,500 p.a.

The TECHNICAL PUBLICATIONS GROUP is housed in a modern building, pleasantly situated on the Cheshire boundary within easy access to town and rural areas. Conditions of work are excellent.

Application forms can be obtained from **T. J. Lunt, Staff Manager, Ferranti Limited, Hollinwood, Lancs.** Please quote reference PC.

AMPEX

An excellent opportunity arises for a young intermediate

DRAUGHTSMAN

for work on precision magnetic recording equipment with applications in the fields of sound, data and television recording. Experience of electronic and chassis layout and O.N.C. an advantage, but main requirements are a keen interest in the subject and a resourceful mind.

Contributory Pension and Life Assurance Scheme,

Free Sickness Insurance.

Please apply: The Personnel Manager,
Ampex Electronics Ltd.,
72 Berkeley Avenue, Reading.
Tel.: Reading 55341

WESTLAND AIRCRAFT LIMITED
SAUNDERS-ROE DIVISION

have vacancies for

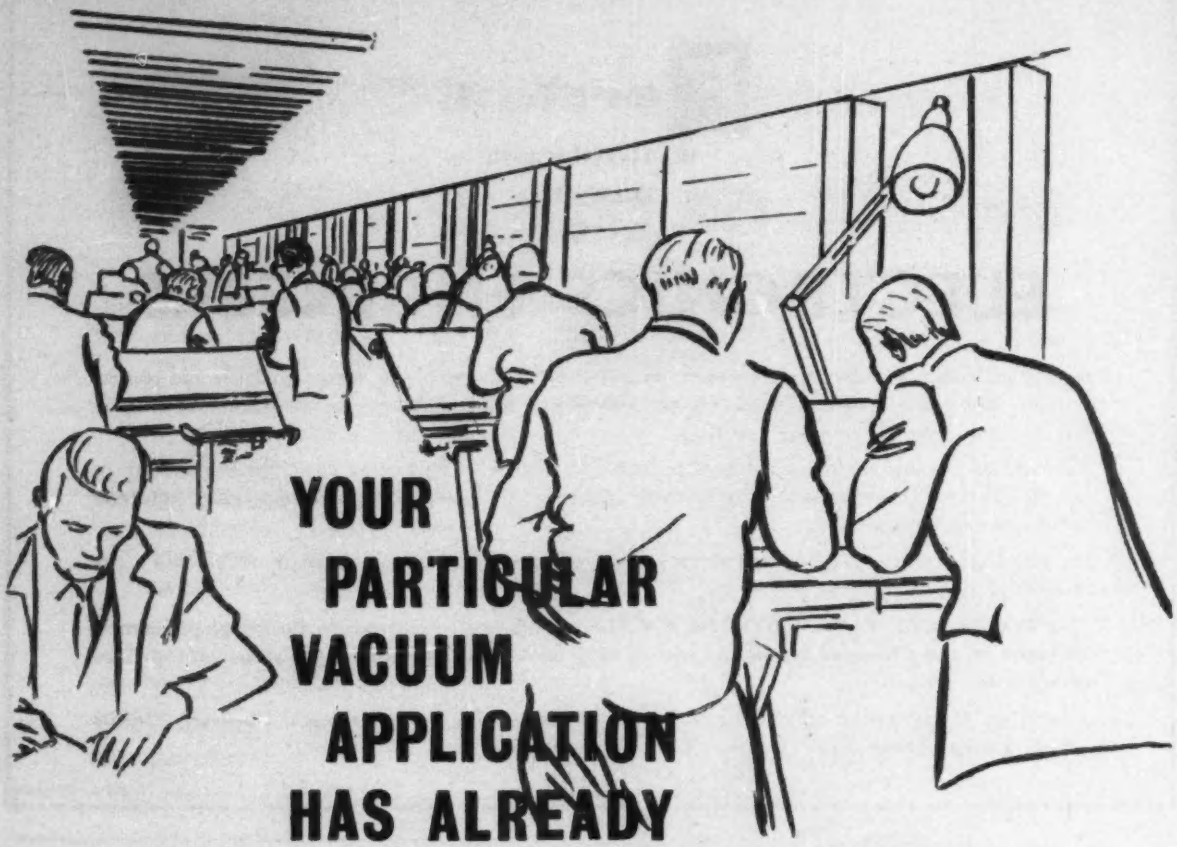
ENGINEERS

to work on the trials and further development of "Black Knight" at High Down, Isle of Wight, and in Australia. Applicants, who should have experience in Guidance, Instrumentation or an allied field, together with enthusiasm and initiative, should forward details of their careers to date, quoting ref. EE/99 to the

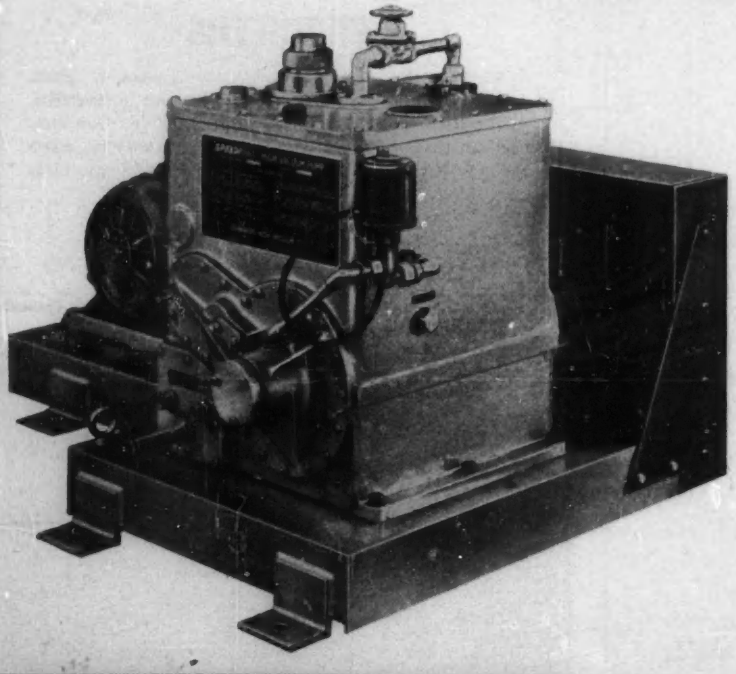
Personnel Officer,
Westland Aircraft Limited,
Saunders-Roe Division, East Cowes, I.W.

EE 40 289 *for further details*

EE 40 290 *for further details*



YOUR PARTICULAR VACUUM APPLICATION HAS ALREADY BEEN *CONSIDERED !*



YOU'LL FIND THE ANSWER IN THE RANGE OF 14 QUIET "SPEEDIVAC" HIGH VACUUM ROTARY PUMPS CAPACITIES FROM 22 1/minute to 3000 1/minute

EDWARDS HIGH VACUUM LTD	MANOR ROYAL	CRAWLEY Crawley 1100	SUSSEX	ENGLAND

INDEX TO ADVERTISERS

A

A.P.T. Electronic Industries Ltd. 158
AEI—Birlec Ltd. 7
Achars Ltd. 213
Adcola Products Ltd. 202
Advance Components Ltd. 67, 104, 165
Airmec Ltd. 129
Alkan, M. L. Ltd. 50
Alma Components Ltd. 3
Alston Capacitors Ltd. 208
Ampex Electronics Ltd. 231, 233
Ampex Great Britain Ltd. 23
Anca 216
Anders Electronics Ltd. 218
Ardente Acoustic Laboratories Ltd. 194
Armstrong Whitworth Equipment 141
Ashburton Resistance Co. Ltd. 212
Asmidar Plastic Moulding Machines Ltd. .. 196
Associated Electrical Industries Ltd. 43, 106, 107, 124, 137, 149, 225
Atkins, Robertson & Whiteford Ltd. 198
Aveley Electric Ltd. 46
Avo Ltd. 139

B

B. & K. Laboratories Ltd. 11
B. & R. Relays Ltd. 20
Barr & Stroud Ltd. 90
Belling & Lee Ltd. 34
Berry's Radio 189
Bir-Vac Ltd. 191
Blackburn Electronics Ltd. 83
Bolton, Thomas, & Sons Ltd. 223
Bradley, G. & E., Ltd. 193
Brandenburg Ltd. .. Cover i, 173, 174, 175
Brauer, F., Ltd. 199
Bribond Ltd. 16
Britec Ltd. 203
British Broadcasting Corporation 230
British Communications Corpn. Ltd. 167
British Electric Resistance Co. Ltd. 190
British European Airways 169
Brown, N. C., Ltd. 195
Broxlea Products Ltd. 204
Bruce Peebles & Co. Ltd. 211
Brush Crystal Co. Ltd. 159
Bullers Ltd. 28

C

Cannon Electric (Gt. Britain) Ltd. 177
Castelco (Great Britain) Ltd. 155
Chance—Pilkington Optical Works 184
Chapman & Hall Ltd. 817
Chilton Electric Products Ltd. 82
Colvern Ltd. 187
Consolidated Beryllium Corporation 14
Continental Connectors Ltd. 10
Counting Instruments Ltd. 47
Cressall Manufacturing Co. Ltd. 119
Crofts (Engineers) Ltd. 55

D

Dartronic Ltd. 168
Datum Metal Products Ltd. 44
Davall, S., & Sons Ltd. 190
David Dowling Ltd. 208
Davis, F. T. (Kings Langley) Ltd. 208
Davis, Jack (Relays) Ltd. 207
Dawe Instruments Ltd. 146
Decca Radar Ltd. 69
Dobbie McInnes Ltd. 212
Donovan Electrical Co. Ltd. 120
Dowding & Doll Ltd. 66
Du Pont Co. (U.K.) Ltd. 101
Dynatron Radio Ltd. 209
Dzus Fastener Europe Ltd. 219

E

E.M.I. Electronics Ltd. Inserts facing pages 16 & 17, 120 & 121
Edwards High Vacuum Ltd. 234
Egen Electric Ltd. 215
Ekco Electronics Ltd. 5
Electro Methods Ltd. 171
Electronic Instruments Ltd. 33
Electrosil Ltd. 68
Engineering & Technical Publications Ltd. .. 209
English Electric Co. Ltd. (Transformers) 181, 228
English Electric Valve Co. Ltd. 95
Ericsson Telephones Ltd. 125, 147, 186
Erie Resistor Ltd. .. .. .. Cover iii
Evans, Frederick W., Ltd. 233

F

F.N.I.E. 197
Falk, Stadlemann & Co. Ltd. 117
Farnell Instruments Ltd. .. .. Cover ii
Ferguson Radio Corpn. Ltd. 228
Ferranti Ltd. 35, 230, 232, 233
Fielden Electronics Ltd. 206, 215
Forrest Transformers Ltd. 201
Fortiphone Ltd. 203

G

Gardner, Henry, Ltd. 195
Gardners Radio Ltd. 103
General Atomics Europe 229
General Electric Co. Ltd. 22, 71
Genevac Ltd. 154
Goodmans Industries Ltd. 94
Graphite Products Ltd. 155
Griffiths, Gilbart, Lloyd & Co. Ltd. 201
Guest, Keen & Nettlefolds Ltd. 130

H

Haddon, Thomas & Stokes Ltd. 213
Hassett & Harper Ltd. 32
Hatfield Instruments Ltd. 99
Hedin Ltd. 191
Hewlett-Packard SA 70, 86, 87
Hirst Electronic Ltd. 138
Hitachi Ltd. 42
Hivac Ltd. 214
Hughes International Ltd. 59

I

I.C.I. Ltd. 92, 230
I.D.M. Electronics Ltd. 121
Imhof, Alfred, Ltd. 126
Industrial & Commercial Finance Corpn. .. 235
Insuloid Manufacturing Co. Ltd. 152
International Electronics Ltd. 18, 19
International General Electric 127
International Nickel Company (Mond) Ltd. .. 188
International Rectifier Co. (Gt. Britain) Ltd. 88
Isora Illuminating Ceilings .. .. Cover iv

J

Johnson Matthey & Co. Ltd. 179
Jones & Rooke (1948) Ltd. 164
Jones & Stroud Ltd. 116
Jones, Walter, & Co. (Engineers) Ltd. 31

K

Kasanna Electronics Ltd. 150, 200
Kay & Co. (Engineers) Ltd. 132
Kuhnke, H., Ltd. 192

If you're expanding then you're borrowing . . .

More permanent capital is what you need—
ICFC can provide long-period loans on fixed terms, and share capital, to businesses in Great Britain

Set up by the English and Scottish banks in 1945, **Industrial & Commercial Finance Corporation Ltd** has provided £70 million to nearly 1000 companies

'CAPITAL FOR BUSINESS'
which explains what the Corporation can do will be sent on request

ICFC

LONDON
7 Drapers' Gardens, EC2 National 8621/5
and branches in industrial centres

EE 40 291 *for further details*

INDEX TO ADVERTISERS *(continued from previous page)*

L

Langham Thompson, J., Ltd. 84, 85, 176
Laxor Electronics Ltd. 208
Linear Ltd. 220
Litchfield Brothers Ltd. 210
Livingston Laboratories Ltd. 153
Lodge Plugs Ltd. 236
London Electric Wire Co. & Smiths Ltd. & Vactite Wire Co. Ltd. 217
Lucas, Joseph, Ltd. 143
Lustertron Electronics Ltd. 210
Lyons, Claude, Ltd. 227

M

M.O. Valve Co. Ltd. 170
MSI Electronics Ltd. 231
Mallory Batteries Ltd. 27
Marconi Instruments Ltd. 24, 25
Marconi's Wireless Telegraph Co. Ltd. .. 97
Markem Machine Agency 17
Marshall of Cambridge Electronics Ltd. .. 198
Marston Excelsior Ltd. 136
Measuring Instruments (Pullin) Ltd. 166
Mervyn Instruments Ltd. 21
Metway Electrical Industries Ltd. .. 195, 209, 221
Microcell Electronics Ltd. 109, 142
Midland & Lowmoor Iron & Steel Co. Ltd. .. 4
Midland Silicones Ltd. 51, 89
Mikro Electrik AG 199
Ministry of Labour 232
Muirhead & Co. Ltd. 77
Mullard Ltd. 49, 56, 57, 79, 81, 110, 111, 114, 151, 162, 180, 183
Multicore Solders Ltd. 37

N

N.G.N. Electrical Ltd. 200
Nagard Ltd. 100
Nash & Thompson Ltd. 2
Neoflex Ltd. 221
Newton Bros. (Derby) Ltd. 154
Nuclear Enterprises (G.B.) Ltd. 219

O

Oliver Pell Control Ltd. 78
Oliver & Randall Ltd. 201

P

Painton & Co. Ltd. 30
Panellit Ltd. 108
Papst-Motoren KG 192
Partridge Transformers Ltd. 155
Plannair Ltd. 96
Plessey Co. Ltd. 64, 128, 178, 231

Q

Quartz Crystal Co. Ltd. 199

R

Radiospares Ltd. 58, 182
Radyne Ltd. 196
Reliance Gear Co. Ltd. 206
Research & Control Instruments Ltd. .. 122, 123
Rists Wires & Cables Ltd. 105
Ritherdon & Co. Ltd. 197
Rivlin Instruments Ltd. 8, 9
Roe, A. V., & Co. Ltd. 232
Rollet, H., & Co. Ltd. 207
Ross, Courtney & Co. Ltd. 213

S

S.I.M.A. 142
S. & D. Rivet Company (Steels & Banks Ltd.) 206
S. E. Laboratories Ltd. 134
Salford Electrical Instruments Ltd. 210, 212
Sanders, W. H. (Electronics) Ltd. 157
Sangamo Weston Ltd. 3
Saunders-Roe Ltd. 231
Savage Transformers Ltd. 12
Scott, James, & Co. (Electronic Engineering) Ltd. 194
Servo Consultants Ltd. 115
Servomex Controls Ltd. 160, 161
Servo-Tek Products Co. Inc. 218
Shardlow Micrometers Ltd. 216
Sheffield Smelting Co. Ltd. 48
Shell Chemical Co. Ltd. 205
Short Brothers & Harland Ltd. 91
Siemens & Halske 135
Sifam Electrical Instruments Co. Ltd. 15
Silentbloc Ltd. 163
Smith, S., & Sons Ltd. 29
Smiths Clocks & Watches Ltd. 193
Smith, John, Ltd. 220
Solartron Electronic Group Ltd. .. 38, 39, 52, 53
Southern Instruments Ltd. 220
Spring Steel Productions Ltd. 152
Standard Telephones & Cables Ltd. 73, 74, 75, 76, 148
Steatite & Porcelain Products Ltd. 41
Sterne, L., & Co. Ltd. 144
Sturdy Electric Co. Ltd. 190
Surrey Steel Components Ltd. 214

T

Talbot Tool Co. Ltd. 214
Taylor Electrical Instruments Ltd. 221
Telcon Metals Ltd. 217
Telegraph Condenser Co. Ltd. 80
Telephone Manufacturing Co. Ltd. .. 93, 172
Telequipment Ltd. 72
Terry, Herbert, & Sons Ltd. 65
Texas Instruments Ltd. 185
Thermal Syndicate Ltd. 156
Thorn-AEI Radio Valves & Tubes Ltd. .. 145
Thorn Electrical Industries Ltd. .. 45, 113
Transitron Electronic Ltd. 63
Transradio Ltd. 26
Tripletone Manufacturing Co. Ltd. 189
Trumeter Co. Ltd. 211
Turner Bros. Asbestos Co. Ltd. 49
Turner, Ernest, Electrical Instruments Ltd. .. 6
Tyer & Co. Ltd. 207

U

U.K.A.E.A. 228
Unbrako Socket Screw Co. Ltd. 54
Uni-Tubes Ltd. 189

V

Vacwell Engineering Co. Ltd. 62
Valradio Ltd. 216
Van Nostrand, D., Company Ltd. 816
Vectron Electro-Physics Ltd. 201
Venner Accumulators Ltd. 118
Vickers-Armstrongs Ltd. 228

W

Walmore Electronics Ltd. 102
Waycom Ltd. 203
Wayne Kerr Laboratories Ltd. 19
Webber, R. A., Ltd. 206
Westinghouse Brake & Signal Co. Ltd. .. 33
Westland Aircraft Ltd. 231
Westool Ltd. 60, 63
Westrex Co. Ltd. 133
Whiteley Electrical Radio Co. Ltd. 221
Wiggin, Henry, & Co. Ltd. 139
Wilkinson, L. (Croydon) Ltd. 192
Winston Electronics Ltd. 196
Woodhill Engineering Co. Ltd. 152

Y

Yokogawa Electric Works Ltd. 102

Z

Zenith Electric Co. Ltd. 98

material answer

Sintox—the alumina ceramic of exceptional insulation characteristics—is superior in tension, compression and cross-breaking. In small assemblies it can be an insulator and a structural support.

Sintox also stands elevated temperatures with little change in its properties, has high thermal conductivity and superior corrosion resistance and—for nuclear application—low neutron capture cross-section.

to design problems . . .

BRAZED METAL/CERAMIC TERMINAL SEALS. These seals are brazed vacuum—tight assemblies capable of withstanding elevated temperatures and pressures under conditions of continuous operation.

SINTOX — A PRODUCT OF LODGE

precision engineering ceramics

Sintox Technical Advisory Service freely available without obligation. Please write for booklet

EE 40 292 *for further details*

LODGE PLUGS LTD., RUGBY, ENGLAND Telephone: Rugby 2166

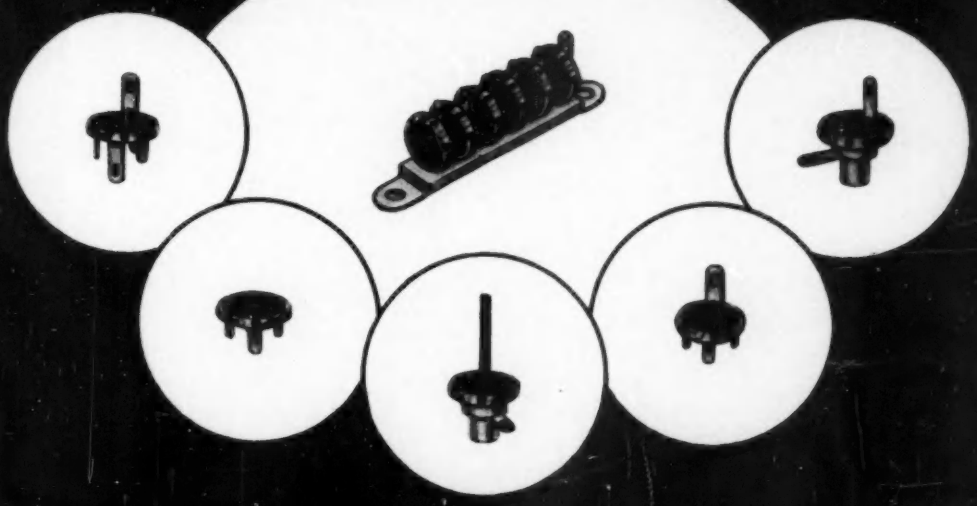
Printed in Great Britain by The Press at Coombelands, Ltd., Addlestone, Surrey, for the Proprietors, Morgan Brothers (Publishers), Ltd., 28, Essex Street Strand, W.C.2. Registered for Transmission by Canadian Magazine Post.

236/68

EE 40 003 *for further details*

Professional

COMPONENTS



BUTTON *Silver-Mica* CAPACITORS

★ ERIE

RESISTOR
LIMITED

cleanliness in a new light...

Standards Room for
Gamet Products Ltd.,
Colchester, Essex.

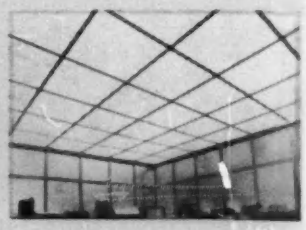
with **ISORA** translucent P.V.C ceilings

ISORA ceilings offer you the following advantages -

- ★ **Clean or super-clean working conditions** Translucent panels can be sealed down and rooms pressurized to achieve the required degree of dust exclusion.
- ★ **Even and diffused lighting** Excellent diffusion coupled with high light transmission (up to 88%) permits highly accurate work without eye strain.
- ★ **Heat conservation** Under appropriate conditions, up to 70% fuel saving.
- ★ **Low cost** Inexpensive to install and to maintain.
- ★ **Consultant service** We have retained the services of consultants who are in a position to advise, without charge to you, on all aspects of clean rooms, pressurized chambers and other technical installations.

This is what ISORA really means

BEFORE **AFTER**



Write or telephone for literature and colour samples

ISORA
Patented

ILLUMINATING CEILINGS LTD.,
A member of the King Group of Companies at Slough

BEDFORD AVENUE, SLOUGH, BUC
Tel: Slough 26851 (3 li